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An analysis of the Navy's permanent change of station planning process and move forecasting models

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An Analysis of the Navy's Permanent Change of Station Planning Process and Move Forecasting Models

by

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THESIS

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William Clinton McQuilkin

December, 1991

Thesis Co-Advisors: Stephen L. Mehay
Thomas P. Moore

ABSTRACT

This thesis provides a general overview and appraisal of the Navy's Permanent Change of Station (PCS) planning process, with an emphasis on PCS Move Forecasting Models. A study was conducted of all organizations with a role in the management and budgeting of PCS funds. Interviews were conducted with representatives from each organization in order to determine the flow of information between these organizations, and to identify the processes involved in PCS management. This thesis further evaluated the PCS move models currently used to forecast PCS move requirements. Finally, this thesis evaluated a prototype model developed by the Navy Personnel Research and Development Center which attempts to quantify the impact of a PCS account reduction on personnel unit readiness.

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I. INTRODUCTION

Each fiscal year the Navy moves hundreds of thousands of personnel to meet manning requirements, personnel policies, and readiness objectives. These moves are referred to as Permanent Change of Station (PCS) moves. Although the cost of the PCS portion of the Military Personnel-Navy (MPN) appropriation accounts for only three percent of the total, (the MPN appropriation was $19.4 billion in FY 90), it consistently receives close scrutiny by Congress. This scrutiny is due in part to past mismanagement of the account, which resulted in expenditures exceeding the amount authorized in the budget, and also due to the fact that PCS funds are often viewed as discretionary by members of Congress and others in the review process. Because of this attention from Congress, the Navy requires a means of providing reliable PCS move forecasts that are supported at all levels of the organization, and that provide an accurate basis for budget submissions.

Each proposed PCS budget must be justified from the standpoint of PCS policy and the rationale for moving a specified number of sailors. The PCS budget must also be justified as an accurate forecast of moves for the coming year, given current rotation, training, and other policies. With an annual budget of over $600 million for PCS moves, each

1-percent error in forecasting generates a $6 million error in allocated funds. [Ref. 1]

For budgetary purposes, PCS moves are subdivided into six categories, each of which has an officer and enlisted component. The categories and definitions are summarized below. [Ref. 1: p. 2]

Accession: Travel from the place of enlistment or commissioning or from the point of receipt of orders to the first or new permanent duty station. Travel directly to a school lasting 20 weeks or more after enlistment or commissioning is also classified as an accession move, as is attendance at flight school by newly commissioned officers.

Training: Travel within the continental United States (CONUS) to and from a permanent duty station and a training school for a course of 20 weeks or more. Travel from overseas to a school is not included, nor is travel directly from a school to overseas. As noted above, accession travel directly to school is not counted as a training move.

Operational: Travel within CONUS between permanent duty stations or travel between permanent duty stations overseas when no transoceanic travel is required.

Rotational: Travel between CONUS and an overseas permanent duty station or travel between overseas duty stations requiring transoceanic travel.

Unit: PCS moves in connection with the relocation of an organized unit.

Separation: Travel upon separation from the service between the last permanent duty station and the home of record or point of entry into the service. Travel from overseas for the purpose of separation is included in this category.

The Navy also categorizes these moves into "mandatory" moves and "discretionary" moves. Mandatory moves include accession, separation, and organized unit moves. These are labeled mandatory because they are determined by end strength requirements and force structure, and are relatively fixed. These mandatory moves command priority and are managed within the Department of the Navy by Pers-7 (whose functions are addressed in more detail in Chapter II), and are not considered "normal" detailing moves.

Discretionary moves include operational, rotational, and training moves (ORT). These moves are a function of sea/shore rotation policies, current management practices, and training plans. The number of moves which incurred an obligation of funds in FY 90 for each of the six types of PCS moves is listed in Table 1. [Ref. 2]

TABLE 1.--FY 90 PCS COST MOVES

Move Type	Officer	Enlisted
Mandatory		
Accession	5,888	68,422
Separation	5,954	73,625
Organized Unit	810	6,399
Sub-total	12,652	148,446
Discretionary		
Operational	8,618	39,626
Rotational	5,888	29,613
Training	8,693	26,539
Sub-total	23,199	95,778
Total	35,851	244,224

Source: NPRDC Historical Execution File 1980-1990

The forecasting of discretionary moves has been the focus of several previous studies. It is an area where some control can be exercised and, more importantly, where cost savings can be realized. Figures 1 and 2 depict enlisted and officer discretionary aggregate move patterns, by month, for ten fiscal years (FY 81 through FY 90) [Ref. 2: p. 3]. These are moves that have actually occurred. The erratic patterns could suggest either that a problem exists in the execution phase of PCS management, or that the Navy has failed to obtain budgetary support for its move policies, or perhaps the move policies themselves are producing this erratic behavior. The preponderance of moves occur in October, at the beginning of the fiscal year, while there is a steep decline in the number

of moves occurring at the end of the fiscal year. Additionally, as might be expected, the number of moves substantially increases during the summer months when parents most desire to move school-aged children.

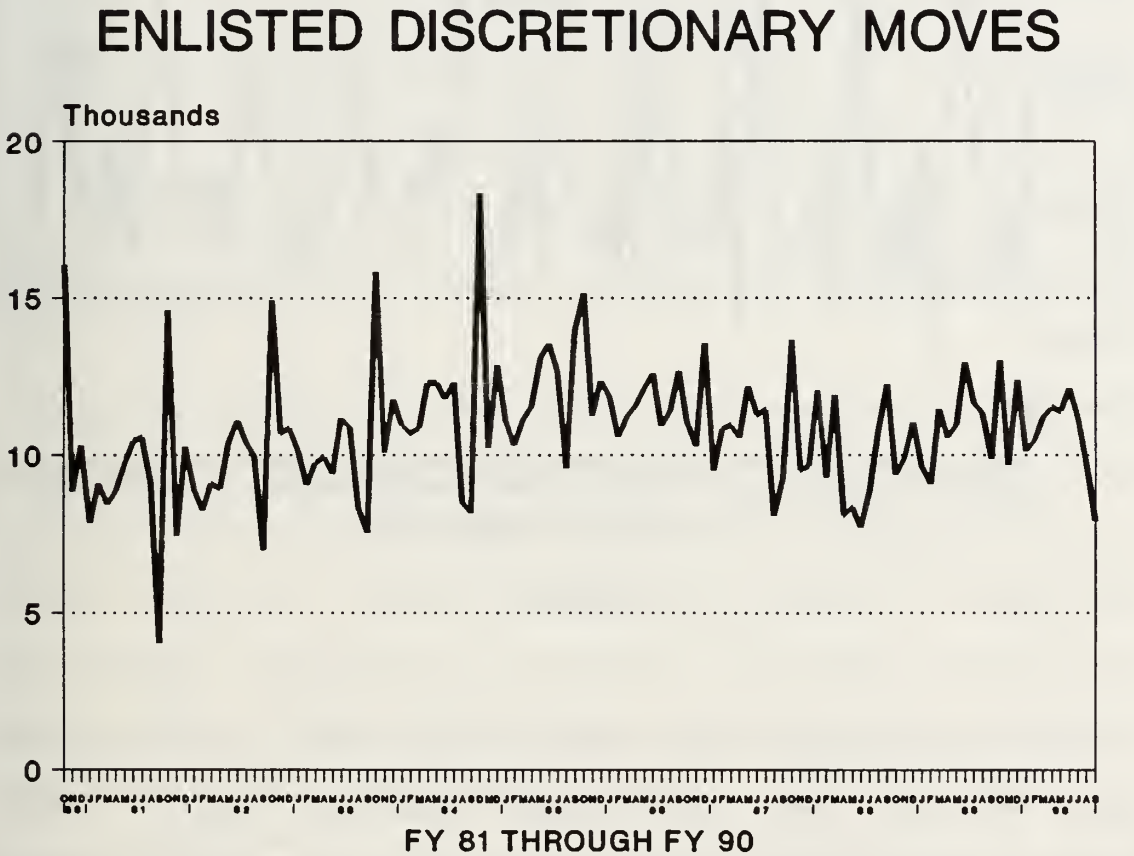


Figure 1

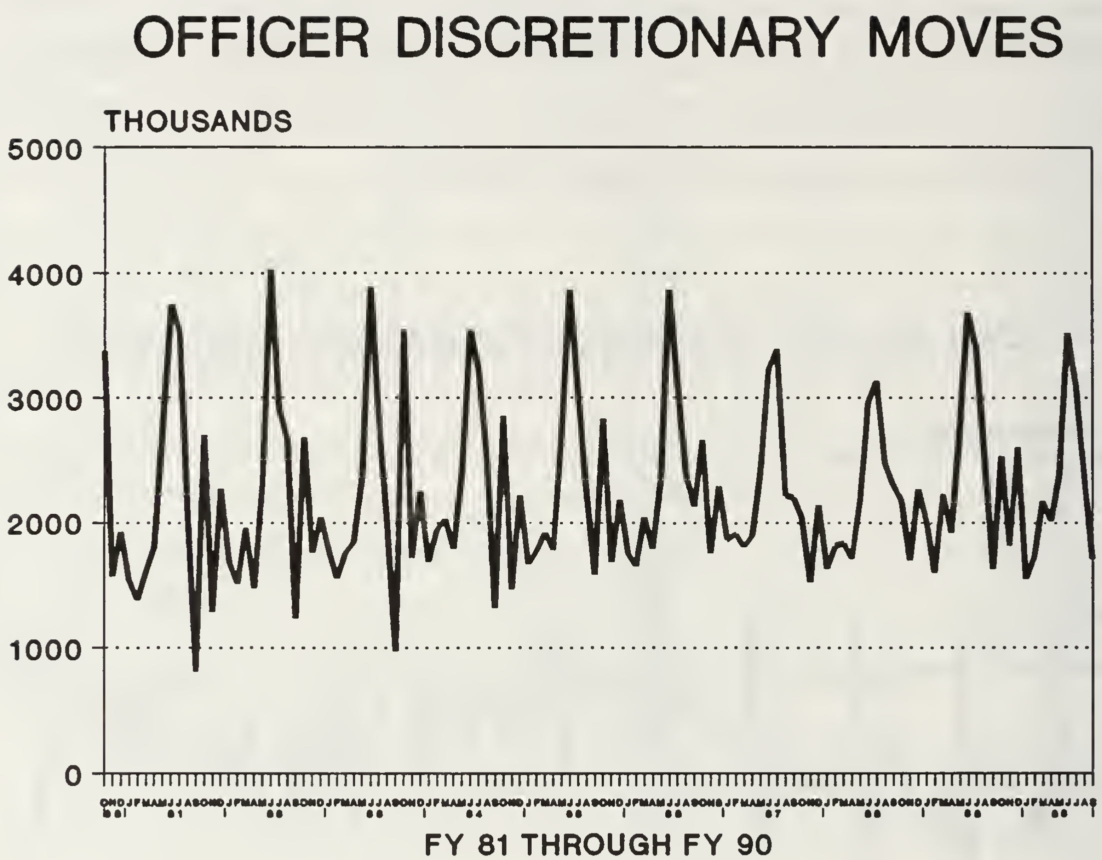


Figure 2

In terms of cost, the average discretionary move is three times greater than the average mandatory move. Among discretionary moves there is considerable variation in average costs. This is particularly true for the rotational move which involves transoceanic travel and is the most costly type of move. Table 2 provides historical discretionary average move costs for both officer and enlisted for each of the five fiscal years from 1983 to 1987. The totals consist of a weighted average of the officer and enlisted moves.

TABLE 2.--AVERAGE COST PER DISCRETIONARY MOVE (IN DOLLARS)

DIS. MOVES	FY-83	FY-84	FY-85	FY-86	FY-87
OPERAT.	2310.03	2120.57	2304.90	2602.45	2589.13
OFF.	3840.85	3503.22	3751.43	4447.54	4502.20
ENL.	1983.93	1839.79	2033.49	2233.11	2153.63
ROTAT.	5995.96	5466.77	4996.29	5324.40	5372.24
OFF.	9708.68	10265.1	9411.55	9690.29	9710.49
ENL.	5260.88	4549.98	4261.40	4500.08	4484.65
TRAIN.	1644.34	1521.90	1575.06	1575.41	1677.09
OFF.	3286.92	2819.88	3010.63	3229.04	3297.60
ENL.	1164.27	1110.30	1175.36	1126.48	1167.74
TOTAL DIS.	3077.47	2964.96	2913.42	3096.83	3148.13

Source: PERS-203

Another perspective may serve to illustrate the apparent incongruity of PCS moves as they relate to total enlisted end strength. Using source data obtained from Commander Robert Hillary, Pers-402, Figure 3 depicts the number of funded PCS moves versus enlisted end strength for fiscal years 1975 through 1997. The 1992 through 1997 end strength figures represent projected end strength based on the most current end strength plans. As the graph shows, there is an inverse relationship between enlisted end strength and PCS moves executed. The source data revealed that in 10 of the 15 years between 1975 and 1990 this inverse relationship existed. This might support the author's hypothesis that PCS policies in the aggregate are leading to increased PCS move requirements at a time when total enlisted end strength is decreasing.

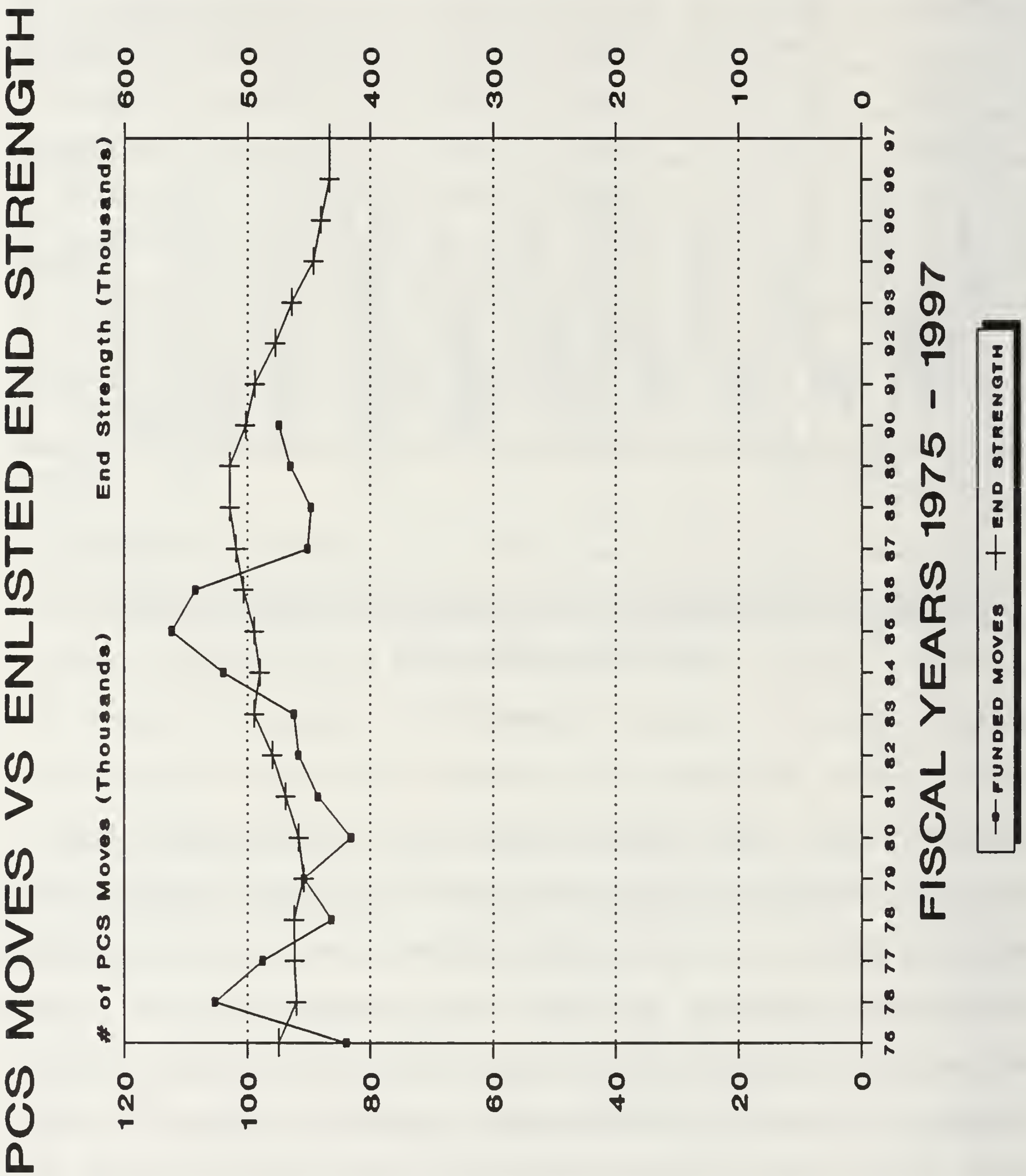

PCS MOVES VS ENLISTED END STRENGTH
# of PCS Moves (Thousands)
End Strength (Thousands)
FISCAL YEARS 1975 - 1997
FUNDED MOVES
END STRENGTH

Figure 3

Consideration must also be given to some of the external influences affecting the PCS decision environment. The Office of the Secretary of Defense (OSD) has been in the process since 1989 of creating a joint service Permanent Change of Station Management Information System (PCSMIS). This system, located at the Defense Manpower Data Center (DMDC) in Monterey, California, is tasked with maintaining a centralized data base on active duty personnel assignment actions and PCS costs. [Ref. 3: p. 11]

It is the author's opinion that the PCSMIS system is a long way from providing useful information to Department of Defense (DOD) managers exercising their oversight role because much of the data in the system has not been updated since 1989, and because 1991 queries to the system from DOD were almost nonexistent. However, use of the system when fully implemented could call into question some of the assignment actions and planning assumptions addressed in subsequent chapters of this thesis. For example, data on early detachments presented in Chapter IV could suggest that there is a problem with using the Projected Rotation Date (PRD) as the primary planning assumption in PCS forecasting models.

This thesis addresses the PCS planning and budgeting process with an emphasis on methods and models used to forecast PCS moves. Chapter II provides an overview of the PCS budget process using a functional approach. It reviews all of the organizations with a role in the management and

budgeting of PCS funds, examines existing interfaces, and provides a time line for these processes. Chapter III analyzes the existing Navy Personnel Research and Development Center (NPRDC) PCS forecasting model, focusing on problems identified with the model. Chapter IV examines alternative methods for forecasting PCS moves and Chapter V contains the research conclusions and recommended actions to improve the Navy's PCS budget process.

II. OVERVIEW OF PCS MANAGEMENT AND BUDGETING

The management of Permanent Change of Station (PCS) moves and the budgeting of funds for these moves involves multiple organizations performing a variety of functions. This chapter describes these organizations and summarizes their respective roles and interfaces with regard to PCS management and budgeting. Figure 4 on the following page illustrates the relationships between the various organizations and the flow of data, reports and information [Ref. 3: p. 32]. Figure 4 will be used as a framework for the discussion in this chapter.

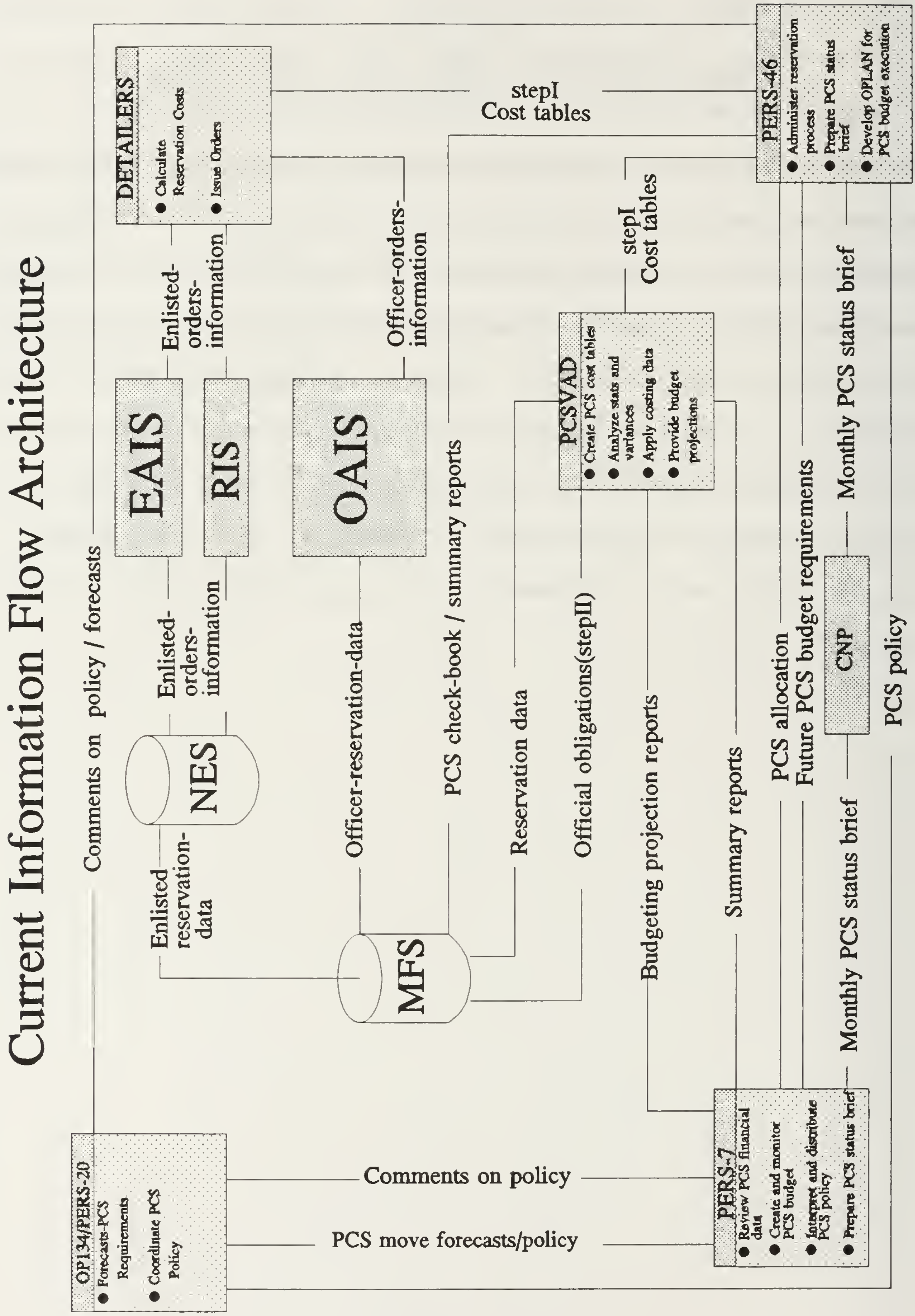

Current Information Flow Architecture
OP134/PERS-20
Forecasts-PCS Requirements
Coordinate PCS Policy
Comments on policy / forecasts
DETAILERS
Calculate Reservation Costs
Issue Orders
EAIS
RIS
OAIS
NES
MFS
Enlisted-orders-information
Enlisted-reservation-data
Officer-orders-information
Officer-reservation-data
stepI Cost tables
PCS check-book / summary reports
Reservation data
Official obligations(stepII)
PCSVAD
Create PCS cost tables
Analyze stats and variances
Apply costing data
Provide budget projections
Budgeting projection reports
Summary reports
PCS allocation
Future PCS budget requirements
Monthly PCS status brief
CNP
PCS policy
PERS-46
Administer reservation process
Prepare PCS status brief
Develop OPLAN for PCS budget execution
PERS-7
Review PCS financial data
Create and monitor PCS budget
Interpret and distribute PCS policy
Prepare PCS status brief
Comments on policy
PCS move forecasts/policy

Figure 4

A. ORGANIZATIONS AND ROLES

Within the Bureau of Naval Personnel (BUPERS) there are four key participants in PCS management. They are the Assistant Chief for MPN Financial Management (Pers-7); the PCS Variance Analysis Department (PCSVAD), located at the Defense Finance and Accounting Service (DFAS) in Cleveland, Ohio but reporting to Pers-7 as a field activity; the Assistant Chief for Policy and Career Development (Pers-2/OP-134); and the Assistant Chief for Distribution (Pers-4). A summary of the role of each is provided below.

1. Assistant Chief for MPN Financial Management (Pers-7)

Pers-7 is responsible for the administration and management of the MPN appropriation as well as portions of various other appropriations. Pers-7 reports to BUPERS and ultimately to the Chief of Naval Operations (CPNAV). Pers-7 interfaces with other BUPERS and OPNAV organizations, the Comptroller of the Navy (NAVCOMPT), and other various field activities. [Ref. 3: p. 6]

The MPN appropriation ($19.4 billion in FY 90) includes Strength Costs (89%), Special Pays (8%), and PCS requirements (3%). "Strength Costs" refers to the normal pay and allowances received by service members. The MPN appropriation is a centrally managed account with Pers-7 performing the functional processes of budgeting, accounting, and reporting.

PCS travel is one of six budget activities associated with the budgeting function performed by Pers-7 for the MPN account.

Pers-7, as the manpower claimant, submits an MPN budget to NAVCOMPT in May or June of the year prior to the budget year (the "Off-year"). NAVCOMPT will hold hearings on the proposed budget for approximately two months. This is where various portions of the budget are defended prior to submission to the Office of the Secretary of Defense (OSD). This occurs around September of the off-year. OSD will engage in hearings conducted by the Office of Management and Budget (OMB), which will ultimately produce the President's budget. This budget is submitted to Congress in January of the actual budget year. The PCS portion of this budget is subject to review at any stage in this process.

The PCS budget is created and monitored by Pers-71, which is the division within Pers-7 responsible for PCS management and budgeting. As mentioned in Chapter I, there are basically two categories of moves: mandatory and discretionary. Pers-7 treats each of these categories separately in creating the PCS budget as well as in executing the budget.

Mandatory moves, which include accession, separation, and organized unit moves, are less controllable and have a priority over discretionary moves. The funding and execution for these moves is controlled directly by Pers-7 rather than the PCS execution manager, Pers-46.

In forecasting the numbers of mandatory moves, Pers-7 first determines the specific numbers of accession and separation moves based on officer and enlisted end strength plans and their respective retention rates. Homeport changes and unit establishment/disestablishment reports received from OP-80 are used to determine organized unit move requirements.

The important distinction made during the budgeting process between mandatory and discretionary moves is that Pers-7 forecasts the actual numbers of mandatory moves (with the modeling assistance of PCSVAD). Pers-7 then attempts to "cost-out" these moves in creating the budget.

In contrast, discretionary moves are modeled by OP-134/Pers-20 as part of the Program Objectives Memorandum (POM) process. These figures are then reviewed and commented on by Pers-46. Then the cost of these "numbers of moves" is estimated by Pers-7. This is significant due to the fact that it is the discretionary moves which have historically been the most difficult to forecast and they are the moves that receive the closest scrutiny by OSD and Congress.

Pers-7 works with Pers-463 to prepare the PCS status brief which is presented monthly to BUPERS. All information distributed on PCS funds is released by Pers-7, even though most of the reports disseminated for use by other organizations come from PCSVAD.

2. Assistant Chief for Distribution (Pers-4)

Pers-4 is responsible for assigning military personnel to duty stations by writing Permanent Change of Station Orders. Pers-4 writes the majority of PCS orders, except those for non-designated personnel who are handled by the Enlisted Personnel Management Center (EPMAC), and those written by certain field activities with the authority to write PCS orders. Pers-463, as the Distribution Manager, is responsible for the management of PCS funds within Pers-4. [Ref. 3: p. 7]

Currently, PCS costing is computed in a two-step process. Step 1 occurs when the detailer writes the orders. This is labeled a "reservation" of PCS funds. Reservation amounts are derived from "step 1 cost tables" prepared by PCSVAD. These cost tables consist of historical average cost per move rates based on pay grade, distance and location of move, and the number of primary dependents. Each set of orders has a reservation cost associated with it.

This reservation cost is manually entered from the step 1 cost tables along with all other details of the orders into the Officer Assignment Information System (OAIS) or Enlisted Assignment Information System (EAIS). Although EAIS is automated, there are many instances when its use would miscalculate the reservation cost. Consequently, approximately fifty percent of enlisted orders are written

through a manual system. These issues are addressed in detail in Section B of this chapter.

Pers-463 plans the allocation of funds within Pers-4 through the creation of a time-phased Operation Plan (OPLAN). The OPLAN is a distribution plan which details move requirements on a monthly basis. Pers-463 monitors the execution of the OPLAN, contributing information for the monthly PCS status brief along with Pers-7. The OPLAN is not automated. [Ref. 3: p. 7]

Pers-4 also has a role in budget preparation as a supporting player to Pers-7 and Pers-2. Because the Pers-2 organization has not been introduced yet, a brief discription of their role is provided to help illustrate Pers-4's supporting position.

Pers-2 is responsible as a program manager for developing PCS requirements as part of the Program Objectives Memorandum (POM) process. The POM identifies move requirements in the out-years as part of the Six Year Defense Plan (SYDP). Pers-4 is supposed to participate in this process, validating Pers-2's numbers, as well as providing information to help in forecasting move requirement numbers.

The entire planning and budgeting process is very dynamic and things can change significantly from the time the actual number of planned moves is estimated (POM), until the actual execution phase. One example of this dynamic nature would be caused by a policy change that affects overseas tour lengths.

Hence the requirement for constant interaction between Pers-4, Pers-2, and Pers-7. The budgeting process allows a certain amount of flexibility for unforseen changes, as described above, as long as information about the effects are accurately quantified and provided in a timely manner. Pers-4, as Director of Distribution, and specifically Pers-463, as the Distribution Manager, must concern itself with first identifying actual or potential policy changes and then ensuring that the ramifications of these changes are entered into the budget process.

3. Permanent Change of Station Variance Analysis Department (PCSVAD)

PCSVAD, located at the Defense Finance and Accounting Service (DFAS) in Cleveland, Ohio, has the sole authority to create obligations for PCS move costs. Obligations are a critical part of the budget process as they represent amounts that will be expended from the PCS account by the Accounting Division of Pers-7. Obligations are incurred in the month that the PCS orders are executed by the member. At the expected date of the move, PCSVAD converts the step I reservation into a "step II" obligation.

The step II obligation is computed based on information contained in the Travel Information Form (TIF) obtained from the member making the move. It is the responsibility of the member to fill this card out and mail it to PCSVAD prior to

commencement of travel. The TIF contains the specifics of the move that may have been unavailable at the time the orders were written. This includes up-to-date information on the number of dependents accompanying the member, approximate weight of the household goods shipment, etc. If this form is not received (current compliance rate is only approximately 50%), PCSVAD transfers the reservation amount to an obligation using the original step I cost estimate.

PCSVAD creates the actual obligation and compares this to the reservation amount for a variety of reasons to include: (1) to identify trends which would affect the accuracy of the step I cost estimate tables; (2) to identify variations of interest to the Distribution Management and Control Division of the Distribution Department (Pers-463); and (3) to provide budget projections to Pers-7. PCSVAD accomplishes this last function by providing an accurate average move cost to enable Pers-7 to attach a dollar amount to the forecast number of moves. [Ref. 3: p. 5]

PCSVAD is also responsible for creating and updating the cost tables upon which the reservation costs and actual obligations are based. A tremendous amount of geographic and economic data is statistically analyzed and incorporated into these cost tables. The economic data is received from the Military Traffic Management Command (MTMC) and the Military Airlift Command (MAC) in the form of transportation rates. These rates are updated semi-annually based on commercial van

rates, transoceanic shipment costs, fuel costs and general inflation. The cost tables are updated as required in order to accurately reflect the average cost per move for each move category. However, it is generally accepted by Pers-7 that it would not be cost-effective to produce these cost tables more frequently than semi-annually.

The step I tables are distributed in "paper form" since recent attempts to automate the tables have proven to be only marginally successful. This is because the automation of the step I cost tables was attempted by NPRDC as a component of the Enlisted Personnel Allocation and Nomination System (EPANS).

EPANS was a project designed to provide computerized assistance to detailers by automating the assignment process. EPANS was to nominate people to available billets as well as to aid in cost calculations. While still in the testing phase, EPANS was evaluated as unsatisfactory and the project was terminated. Since no separate PCS cost module had been developed, the automation of the step I tables was also halted.

Pers-45 has since requested a separate PCS cost module that would automate the step I costs in the order writing system. A start date for this project has not been identified at the time of this writing.

4. Assistant Chief for Policy and Career Development (Pers-2)

Pers-2 is the branch responsible for formulating policy governing military personnel. PCS policy falls within the scope of their authority. PCS policy direction is determined by Congress, the Secretary of Defense, the Chief of Naval Operations, and input from other sources within the Navy. Within Pers-2, Pers-22 coordinates the review and distribution of PCS policy information. Comments and policy feedback are collected from Pers-46 and Pers-7. Pers-22 evaluates these comments, makes any desired changes, and then promulgates official PCS policy. [Ref. 3: p. 7]

The flag officer in charge of OP-13/Pers-2 has dual reporting responsibilities. He is within the organization of the Chief of Naval Operations as a manpower planner and reports to BUPERS for policy and career development. Within the OPNAV organization, OP-13/Pers-2 is responsible for forecasting PCS requirements. These requirements are determined as part of the Program Objectives Memorandum (POM) process.

The POM represents the programming phase of the Navy's Planning, Programming, and Budgeting System (PPBS). The POM is essentially a biennial decision-making process which seeks to translate planning forces and fiscal guidance constraints into achievable packages (Programs). PCS requirements must be determined and included as part of the POM. The POM planning

begins in the September prior to the budget year (off-year) and is submitted to OSD in April of the budget year (on-year). The results of the POM are submitted as changes to the Six Year Defense Plan (SYDP).

Pers-20 forecasts PCS move requirements for the upcoming budget year and for five out-years during the POM process. For this purpose, input data is received from the Enlisted Master Records (EMR) and Officer Master Records (OMR) files. These files contain Projected Rotation Dates (PRDs) on all service members. Other information comes from Pers-11 for training quotas of 20 weeks or longer, as well as the inputs previously discussed from Pers-46 and Pers-7.

Pers-20 also works very closely with Pers-7 in creating the PCS budget. As mentioned previously, Pers-7 attaches actual dollars to the move estimates in budget formulation. Pers-20 also plays a supporting role in monitoring the execution of the PCS budget. This execution monitoring assistance action is requested by Pers-4 and Pers-7 on a continuing basis as a means of providing feedback on the accuracy of the original move forecasts.

B. INFORMATION RESOURCES

The foregoing section introduced all of the organizations involved in the management of PCS funds and their respective roles. This section details the information resources available to these organizations and examines the existing

interfaces between them. A brief description of each information system is provided below:

MFS: The Military Personnel-Navy Financial Management System (MFS) is an automated system designed to provide Pers-7 with the means to effectively manage and control the MPN and RPN appropriations. Within this system, implemented in 1976, resides a PCS module which is used to store and report information relative to PCS management. Specifically, MFS is the original storehouse for current PCS reservation data. MFS provides the link to PCSVAD for bureau orders and associated reservation cost data. [Ref. 3: p. 6]

MFS was created so that the detailers could better manage their "checkbooks." Each enlisted detailer within Pers-40 (the Enlisted Assignment Division) is allotted funding from which to issue orders. This allotment then serves as a "checkbook" as orders are written against it. MFS provides weekly reports which provides a summary of reservations made by detailers and obligations entered by PCSVAD. The primary users are the execution manager of PCS funds (PERS-463) and Pers-7 (as the major claimant). MFS also stores obligation and expenditure data and serves as a pass-through of reports distributed within BUPERS and PCSVAD.

The MFS software runs on the Consolidated Data Center (CDC) IBM 3081 mainframe computer located in Cleveland, Ohio. The support staff, however, is located at BUPERS in the Navy Annex, Washington, D.C. The PCS portion of MFS uses

approximately eighty-five percent of the MFS system's storage requirements. It is important to note that although MFS provides the detailers and distribution managers with PCS checkbook balances, these are only interim reports. The official account balances are obtained from PCSVAD through their database (PRODS). There currently exists no single shareable data base for PCS data.

PRODS: PCSVAD's PCS Reservation/Obligation Data Base System (PRODS) is located on the CDC's IBM 3081 mainframe computer located in Cleveland, Ohio. PRODS creates the official obligations and also creates reservations for those orders that are written by field commands. The source of input data for obligations is the Travel Information Forms (TIF) submitted by the members performing the travel. As mentioned earlier, TIF submission compliance averages about fifty percent. If the TIF is not submitted, PRODS converts the step I reservations into step II obligations using the original reservation amount. All step II costs are inflated a little more than 1 percent as a margin of safety to prevent overexpenditure of the PCS account.

PRODS also creates the cost tables used to generate both reservations and obligations. The source of input for these calculations are PCS expenditure history files, geographic data, and transportation rates provided by MAC and MTMC to PRODS.

PRODS interfaces directly with MFS to receive reservation data and also to provide obligation data. Both database systems compare obligations to reservations. It is PRODS output, however, that is used by Pers-7 to monitor execution of the PCS budget. As previously mentioned, the reports generated by PRODS provide official detailer checkbook balances.

The current situation of having co-hosted systems (MFS and PRODS are both operated on the same bank of hardware in Cleveland) resulted in the duplication of data in March 1991 due to the conversion of the PRODS system from a Prime minicomputer to the IBM mainframe located at the CDC. Additionally, the CDC, as part of DFAS, Cleveland, is now a DOD activity. Beginning in FY 92, the Navy will be charged by DOD for processing time on the CDC. These processing costs have not been factored into the FY 92 PCS budget.

EAIS: The Enlisted Assignment Information System (EAIS) is an automated order writing system used by enlisted detailers to generate orders. It is menu-driven and contains a logical sequence of data entry screens that enable a detailer to quickly and easily "cut" a set of orders. The step I cost for a set of orders, however, is manually inputed by the detailer. The detailer computes the step I cost using the cost tables. A critical function that EAIS performs, with respect to the management and tracking of PCS funds, is the construction of the Customer Identification Code (CIC).

The CIC is an eight-digit code that consists of five elements: the type of move, the reason for travel, the fiscal year, the detailing branch, and the Budgeting Operating Target (OPTAR) fiscal manager. The CIC is used as a tracking device by PCSVAD. It provides the link between each leg of a set of orders (e.g., schools, temporary duty stations, etc.) and the ultimate duty station. PCSVAD never sees the actual orders, therefore it must use the CIC to correlate each leg of a move to the original orders. Reservation and obligation costs associated with a set of orders are accounted for as a whole and the CIC allows for a "sum of the parts." While CIC construction is automated in EAIS, on-site interviews with detailers conducted during the research revealed several problems in this area.

One problem arises whenever a detailer wishes to send a person to an Accounting Category Code (ACC) 341 school (19 weeks or less) enroute to his/her permanent duty station from an accession school (the ACC is a component of the CIC). In this situation EAIS automatically constructs a CIC which identifies the move as a training move charged to the detailers training move account. However, for accounting and budgeting purposes, this move is considered an accession move (see Chapter I definitions), i.e., it belongs in an entirely separate PCS account. In effect, EAIS counts this move twice since by definition schools less than 20 weeks performed in conjunction with an accession are counted as only one move.

It is the author's opinion that double counting PCS moves in this manner could lead to forecasting errors in PCS forecasting models. This is because the current PCS forecasting model is a time-series forecasting model. Any over-count in one year could bias the move estimate for the following year's forecast.

Another example of where the automatic construction of the CIC caused problems was during the decommisioning of the USS Midway. This resulted in a change of homeport for over 5,000 sailors. EAIS listed the homeport as San Diego, which was the eventual homeport; however, the actual homeport at the time of the move was Yokosuka, Japan. This would have resulted (and in some cases did) in charging the account for an Operational move when in fact a Rotational move (the most costly of moves) was involved.

Similarly, detailers expressed reservations about using the dependent information available in EAIS. Dependent data is often not up to date and could result in the miscalculation of the step I cost. For example, if a member was separated or divorced and therefore not planning on moving any dependents, and EAIS still showed the original number of dependents, then the reservation cost would be overstated. In most cases the detailer will verify this information over the phone with the service member.

In each of the cases mentioned above, as well as for several others, the detailer must forego writing the orders in

EAIS. Instead, the detailer will write the orders and manually construct a CIC in an alternative system called the Readiness Information System (RIS). The original advertising for EAIS was that it would interface with NES, but the two systems would not be dependent on one another. Currently Pers-463 managers are not confident enough in the EAIS system to allow it to provide a direct feed to MFS. This is due to the inherent problems with the system identified in this section. The general feeling among those interviewed is that EAIS is a prototype system that was stood up as a production system. A need was expressed by detailers and financial managers alike to make improvements to EAIS to bring the system more in line with the OAIS system.

RIS: The Readiness Information System (RIS) is an information retrieval system maintained by EPMAC and was the "old" manual order writing system prior to EAIS. It allows detailers to modify a set of orders to include their best estimate of the PCS cost. This will be the amount actually charged against the "checkbook balance." The detailers actually write orders in two different systems, EAIS and RIS. The detailers make roughly equal use of EAIS and RIS during the process of writing orders. Both RIS output, containing orders information, and EAIS output pass through the New Enlisted System (NES) on the way to update enlisted personnel files in MFS.

NES: The New Enlisted System (NES) acts as a pass-through for reservation data from EAIS and RIS to MFS. NES is part of the personnel data network. The primary function of NES is to collectively edit and update the Enlisted Master Records (EMR) file. NES updates to the personnel and financial master files are run every Monday, Wednesday, and Friday.

OAIS: The Officer Assignment Information System (OAIS) is an automated order writing system used by officer detailers to generate orders. Designed concurrently and with the same purpose in mind as its sister system, EAIS, it is not plagued by the problems associated with EAIS. There are two primary reasons for this. First, OAIS is subject to better input control; and secondly, it is designed better.

There are far fewer officer detailers and, generally, they are better trained. This allows the distribution department to verify all cost information on officer orders prior to transmission of the orders to PCSVAD. The end result is fewer input errors. There are system design differences between EAIS and OAIS as well. The most important difference is that OAIS does not automatically generate the CIC. The officer detailer must enter the CIC in the system in a manner similar to what the enlisted detailer does in RIS. While there is a tradeoff here as far as the time required to enter the CIC, it is more than justified in terms of the reduced orders reconciliation time spent by disbursing clerks in Pers-463.

Finally, OAIS is purely an order writing system. It interfaces directly with MFS. Unlike EAIS, OAIS is capable of properly editing orders information that is used by Pers-7 financial managers. This direct interface provides Pers-7 with up-to-date extracts of reservation data. EAIS orders information, as previously mentioned, must first be edited by the NES system prior to being passed to MFS.

This section has focused on the current information systems available to decision-makers in the PCS environment. Section A identified the respective roles of each organization involved in the process. Chapters III and IV will analyze existing and alternative PCS forecasting models used by financial managers in the annual PCS budget submission.

III. NPRDC PCS FORECASTING MODEL

A. HISTORY

In August 1989 the Navy Personnel Research and Development Center (NPRDC) released a model entitled "Forecasting PCS ORT Moves Using Tree Classifications." This model was designed to provide an objective method to produce PCS move forecasts for use in budget development and execution. The research was sponsored by the Chief of Naval Operations (OP-01) with the work request coming from the Assistant Chief for MPN Financial Management (Pers-7). The NPRDC model represents the only official ORT PCS forecasting model in existence.

B. THE MODEL STRUCTURE

1. Assumptions

The NPRDC model uses a technique known as "tree classification" to generate move forecasts. Tree classification assigns every member of the "target population" (every member on active duty, or coming on active duty, in the Navy during the three-year forecast horizon) to exactly one class. The classes are designed so that the move behavior of the individuals within a class will be homogenous with respect to when they expect to move. [Ref. 2: p. 4]

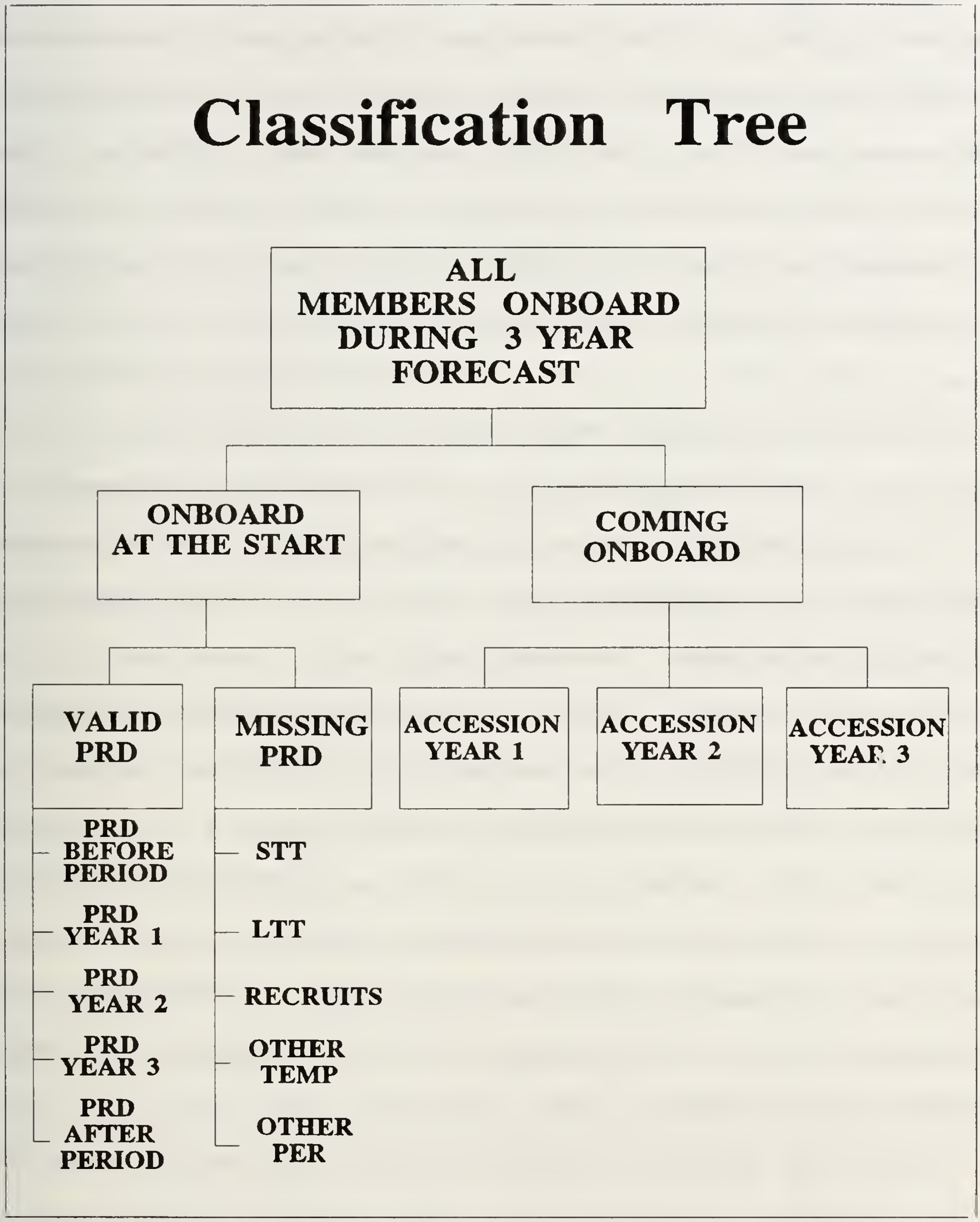
The primary assumption of this model is that current PCS move policies will remain in effect during the forecast

period. A follow-on to this assumption is that the impact of current PCS policies will remain constant within each class. The model also assumes that little is known about future accession plans, thereby dictating the use of the previous year's accessions as an estimate of the forecast year's accessions. Finally it assumes that all PRD changes are a result of policy changes.[1]

2. The Tree Classification

The classification tree used in the analysis (reproduced from the NPRDC report) is shown in Figure 5. [Ref. 2: p. 4] As shown in Figure 5, the NPRDC model provides only a three-year forecast horizon.

[1] The research conducted during this thesis concludes otherwise: that is, PRDs can be changed by the detailers and that these changes are not necessarily a result of any policy changes.



Source: NPRDC PCS ORT Report Documentation [Ref. 2: p. 4]

Figure 5

The tree differentiates between service personnel onboard at the beginning of the three-year forecast and those members who will be accessed by the Navy during the forecast horizon. As mentioned above, the model assumes that little is known about future accessions. Because of this, and in the absence of accession plans, the NPRDC model uses the number of accessions from the most recently completed fiscal year for their forecasts. In light of current plans to reduce end strength, an important improvement in this model would be to use up-to-date accession plans for these future forecasts.

For the members onboard at the beginning of the forecast period, it is assumed that most have a valid projected rotation date (PRD) and that this date occurs within the three-year forecast horizon. These members are classified into one of three groups: members with a PRD falling within the first forecast year; members whose PRD falls in the second forecast year; and members whose PRD is in the third forecast year. All members with a PRD occurring prior to the forecast horizon are classified into a fourth group. Members whose PRD extends beyond the forecast period comprise a fifth classification group. [Ref. 2: p. 5]

The other service members on this side of the tree are those whose PRD is missing. In order to classify and quantify these people, the model uses the Accounting Category Code (ACC), which is an element of the Customer Identification Code (CIC), and which is on every set of orders issued. Based on

the ACC, these members are categorized into five groups: Short-term training (STT); long-term training (LTT) [greater than 20 weeks]; recruit training; other temporary duty (Other Temp); and other permanent duty (Other Per). These last two categories, Other Temp and Other Per, are relatively small miscellaneous categories that represent the remaining members who cannot be classified into the three larger categories.

3. Mathematical Framework

Once individuals have been grouped into classes using the classification tree, PCS move forecasts are made for each class separately. A set of within-class probabilities gives the proportion of the class expected to make PCS moves for each of the next three fiscal years. Within each class, separate forecasts are provided for each type of move (i.e., operational, rotational, or training), and for each type whether it is a "cost" move or a "total" move ("total" moves include those moves that are no-cost moves).[2] Forecasts are further broken down for each detailing branch. For example, one within-class probability would be estimated for the proportion of all enlisted members currently in long-term training who would be expected to make an operational "Cost" PCS move in January FY 92 and who are detailed by Pers-402, the Engineering/Hull Assignment Branch. [Ref. 2: p. 5]

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[2]A cost move occurs whenever a member moves between units that are greater than 50 miles apart.

The forecast for the number of each move type for the non-accession classes is calculated as the product of the number of members onboard in the class at the end of the fiscal year and the within-class probability for that specific type of move. For accession classes, the calculation is the product of the projected number of "surviving" accessions and the within-class probability for that accession class. A sum across classes, by type, yields the final output.

The within-class probability of making a PCS move is calculated using the most recent move behavior of members by type of move whose classes were determined from the Officer Master File (OMF) and Enlisted Master Record (EMR). When calculating the within-class probability of moves one year ahead, the classes are determined from the OMF and EMR one year previous. The within-class probability of a move two years in the future would use the master files from two years previous, and so on. The within-class probability of a FY 92 move for move type A within-class B is defined as:

$$\text{Prob(A,B,FY92)} = \frac{\text{\# of FY91 Moves of Move Type A made by end of FY90 by members of Class B}}{\text{\# of End FY90 members in Class B}}$$

Similarly, the derivation of within-class probabilities for FY 93 is analogous to the FY 92 procedure, except the end FY 89

master files are used instead of the FY 90 master files. [Ref. 2: p. 6]

C. ANALYSIS

1. Accuracy of the Forecasts

The author evaluated the PCS ORT model on its predictive validity in forecasting total PCS cost moves for both officer and enlisted personnel. A comparison was made between actual moves and the forecasted estimates for fiscal years 1989 through 1991. The percentage deviation between the actual values and the estimates was used as a measure of forecast accuracy, using the formula: [Forecast-Actual/Actual]. These values and the percentage forecast error are shown in Tables 3 and 4 for enlisted and officer personnel, respectively.

TABLE 3.--TOTAL ENLISTED COST PCS MOVES FY 89-91 (PCS ORT MODEL FORECAST COMPARISON)

FY	Forecast	Actual	Error (Percent)
1989	86,329	93,931	-8.09
1990	96,462	95,778	0.71
1991	90,882	99,253	-8.43

Source: NPRDC Historical Files

TABLE 4.--TOTAL OFFICER COST PCS MOVES FY 89-91 (PCS ORT MODEL FORECAST COMPARISON)

FY	Forecast	Actual	Error (Percent)
1989	20,607	23,008	-10.43
1990	22,988	23,199	-0.91
1991	22,387	22,423	-0.16

Source: NPRDC Historical Files

The model was further evaluated on predictive accuracy for each of the three categories of moves, (i.e., operational, rotational, and training). This becomes important from a budgeting standpoint because average move costs vary significantly by category. Consequently, budget planners would desire that the forecast errors be lowest for rotational moves, as they represent the most expensive type of move. Conversely, training moves are the least expensive, so a larger forecast error could be tolerated. In addition, officer moves are much more expensive than enlisted moves in every category, on average. Relative to their enlisted counterparts, a higher percentage of officers have dependents and more household goods to transport. Errors in estimating annual move volumes in these categories can generate larger dollar errors despite the smaller move volumes. [Ref. 1: p. 3] The results of the evaluations by type are shown separately for each fiscal year in Tables 5, 6, and 7.

TABLE 5.--FY 1989 PCS COST MOVES BY TYPE

PCS Category	Forecasts	Actual	Error (Percent)
Enlisted			
Operational	31,686	37,595	-15.71
Rotational	28,219	29,515	-4.39
Training	26,424	26,424	-1.48
Officer			
Operational	7,270	8,521	-14.68
Rotational	5,086	5,862	-13.24
Training	8,251	8,625	-4.34

Source: NPRDC

TABLE 6.--FY 1990 PCS COST MOVES BY TYPE

PCS Category	Forecast	Actual	Error (Percent)
Enlisted			
Operational	38,252	39,626	-3.47
Rotational	30,134	29,613	1.76
Training	28,077	26,539	5.78
Officer			
Operational	8,325	8,618	-3.4
Rotational	5,770	5,888	-2.0
Training	8,893	8,693	2.3

Source: NPRDC

TABLE 7.--FY 1991 PCS COST MOVES BY TYPE

PCS Category	Forecast	Actual	Error (Percent)
Enlisted			
Operational	39,310	44,403	-11.47
Rotational	29,247	30,855	-5.21
Training	22,325	23,995	-6.96
Officer			
Operational	8,563	8,929	-4.1
Rotational	5,780	5,689	1.6
Training	8,044	7,805	3.06

Source: NPRDC

Two other measures of forecast accuracy were examined. These were the mean absolute deviation (MAD) and the mean absolute percentage error (MAPE). The MAD calculations simply involves computing the average absolute errors over the three years for which we have data. The MAPE is obtained by computing the absolute percentage error for each time period, summing these percentage errors, and dividing by the number of values used. [Ref. 4: p. 56] Table 8 shows the MAD and MAPE for all move categories.

TABLE 8.--MAD AND MAPE AS A MEASURE OF FORECAST ACCURACY
FY 89-91

COST PCS MOVES BY TYPE (FY 89-91)	MAD	MAPE
Enlisted OP Cost Moves	4125.33	10.21
Enlisted ROT Cost Moves	1141.67	3.79
Enlisted TRA Cost Moves	1201.67	4.74
Total Enlisted Cost Moves	5552.00	5.74
Officer OP Cost Moves	677.67	7.39
Officer ROT Cost Moves	328.33	5.61
Officer TRA Cost Moves	271.00	3.23
Total Officer Cost Moves	882.67	3.83

2. Comments on the NPRDC Model Results

It is hard to determine the acceptable level of accuracy in these forecasts. Interviews conducted during the research revealed that there is no published guidance concerning this matter. It was generally accepted by budget planners, however, that any error over five percent was unacceptable. Evaluating forecast accuracy in terms of actual execution is also clouded by the fact that, to some extent, there is a causal relationship between the original forecast error and the number of moves actually completed during a given fiscal year. For example, if budget requirements were understated (due to the number of moves being under-predicted), a September move might be delayed until October when new fiscal year funds become available. This causal relationship could be explicitly tested for if more years of

actual and forecasted data were available. One suggested statistical technique that could be used to accomplish this is the Student's T-test.

Clearly, the NPRDC model did not perform well in either FY 89 or FY 91 on the enlisted side. In FY 90, however, the enlisted move projection was within one percent of actual execution. For officers, while the FY 89 forecast totals under-predicted requirements by over ten percent, the FY 90 and FY 91 forecasts were within one percent. An explanation for this could be that officer career patterns are more stable and less subject to policy variation.

When asked about the poor showing of the models in FY 89 and FY 91, both Pers-2 and Pers-4 budget officers claimed that any time significant policy variation occurs, the NPRDC forecasts become unreliable. Ironically, according to Pers-46 execution planners, it was ship decommissionings and force structure changes that accounted for the large increase in FY 91 total moves and not the Persian Gulf War.

Commander Hillery, Head, Pers-402, Engineering/Hull Assignment Branch, examined the NPRDC model and provided the following comments. First, his evaluation was that the model presumes valid and stable PRDs which do not allow for changes in PRD, such as population shifts that are not a result of policy changes, and for changes in policies which do affect PRDs.

Population shifts refer primarily to the annual advancement cycle. Enlisted distribution is determined by rate, qualification, and pay grade. Each year the advancement cycle generates move requirements. A unit may be in a position of having too many senior personnel filling key billets. This is, in reality, an artificial population shift, that is, only the margins are moved. Still, there is pressure to move personnel. In the real world, detailers adjust for this by recognizing that there are personnel onboard with a high probability of being advanced and therefore, in this instance, they would be unlikely to fill a gapped billet prior to completion of the advancement cycle.

Policy changes which affect PRDs include sea/shore rotation policies, overseas tour lengths, short-tours with guaranteed re-tours, decommissionings, homeport changes, new commissionings, as well as changes in individual PRDs caused by advancements.

Secondly, according to Commander Hillery, the model uses as an input the number of accessions from the most recently completed fiscal year. Aside from the implications of not accounting for changes in service growth plans, this also does not account for the annual variability in rating classifications. The model also presumes that the accession attrition rate (e.g., "survivors") is stable.

Commander Ayers, Head, Pers-463, listed his concerns by stating that BUPERS needs a PCS forecasting model that can

calculate the "what if" effects of PCS policy changes, which the NPRDC model is unable to do. His reasoning was that the budget system is not flexible enough to deal with the large volume of policy changes. He gave a recent example in which the overseas tour lengths in the Phillipines were changed because of a security problem, which ultimately increased PCS requirements by over $13 million in a single fiscal year.

The most frequently recurring comment on the NPRDC model received during the research was, "Why spend so much time and money generating these forecasts (in terms of manpower and data collection costs) when basically the results are little better than a three-year average?

In light of the expressed reservations with the NPRDC model discussed above, alternative PCS move forecasting methods and models have been developed by BUPERS budget planners. One such model was developed by Commander Keller (Pers-20) in 1988, and it was the move projections from this model that formed the basis for the FY 91 and FY 92 PCS budget submission. Organizational support for this model has since been withdrawn (Commander Keller retired in July 1991), although no viable alternative exists at this time. This model is reviewed in Chapter IV, in which a comparison of forecast accuracy is made with the NPRDC forecasting model.

IV. ALTERNATIVE PCS FORECASTING MODELS

A. PERS-20 MODEL

1. Background

Commander Jack Keller, while assigned to Pers-20 in the summer of 1988, developed his own model for forecasting enlisted operational, rotational, and training move requirements. The reason he developed this forecasting model stemmed from his feeling that the cuts in the PCS budget in fiscal years (FY) 87 and 88 were rather arbitrary. He believed that these cuts were made because the Navy lacked a defensible means of justifying their PCS requirements. According to Commander Keller, when the Navy analyst's forecasts were challenged by OSD and Congressional staffers, the typical response was that the forecasts were their "best guess" estimates.

Commander Keller cited an example that occurred at the end of FY 87. During this time it became apparent that there would be a shortfall in the MPN account. NAVCOMPT directed OP-01 to come up with a $19 million reduction in MPN expenditures. Of this $19 million, the PCS account was targeted for a reduction of $15.7 million, with the remaining balance to be taken from the account for paying service member bonuses.

When Congress reviewed these proposed cutbacks, the Navy described their process as a "rephasing" of PCS moves to achieve the desired savings. In actuality, the Navy was only extending the Planned Rotation Dates for some service members who were due to rotate in one fiscal year to the next. However, Congress responded by saying that if PCS moves can be "rephased" for FY 87, then they can also be "rephased" for FY 88, and cut the proposed FY 88 budget by the same amount. It was at this point that Commander Keller recognized the need for a model to come up with the "numbers" to justify budget requests and to be able to prepare impact statements for the proposed reductions during budget hearings. Commander Keller's model was first used in the FY 89 budget process. The model is discussed in the following section.

2. Model Structure

Commander Keller's model consists of a series of formulas that produce move estimates for three types of moves: enlisted training moves; enlisted rotational moves; and enlisted operational moves. All the data required for the model are obtained in-house (i.e., from BUPERS) and can be stored on a personal computer (PC). These input data consist primarily of PRDs, school quotas, and retention forecasts. Retention statistics are obtained from Pers-2 from the CNO Retention Team. These are overall retention forecasts and are not broken down by term of enlistment or type of duty. A

Macintosh spreadsheet is used to tabulate the various equations that comprise the model.

Commander Keller structured his model based on the assumption that all operational, rotational, and training moves do not have the same priority; that is, some moves must happen. Training moves were considered a first priority as they are necessary to ensure safety of operations and readiness of the fleet. Commander Keller felt that if you are going to maintain a school system in order to train people to use sophisticated weapons systems, you must first be able to move people to and from schools. Therefore, the training moves equation is the starting calculation in the model.

Rotational moves were forecast next because members assigned to overseas billets must move after completing the maximum tour length prescribed by DOD, unless they voluntarily extend their assignment. Although some operational moves also "must" happen, (e.g., nuclear propulsion plant operators), these represent a relatively small number of moves, and therefore, operational moves were determined last and represent a residual of the training and rotational move forecasts. The logic here is that if you are not moving to or from training, and the move does not involve transoceanic shipment, then it is an operational move. The individual formulas for each of the three move categories are discussed in the sections that follow.

a. Training Moves (TRA)

The Training moves estimate begins with input received from the Assistant Chief for Total Force Training/Education (Pers-11). For a given fiscal year, Pers-11 provides a list of training quotas to Pers-20 for all school assignments which are 20 weeks or longer. This figure is then doubled since moves "into" and "out of" school are considered separate moves. The training moves formula is thus:

TRA = (Total quotas at schools greater than 20 weeks) x 2

b. Rotational Moves (ROT)

To order to forecast ROT moves, Commander Keller analyzed them over the preceding three years (FY 86, 87, 88) to find: 1) the rate at which members filled overseas billets by making ROT moves; and 2) the rate at which members leaving overseas made ROT moves. Commander Keller's analysis showed that fifty-nine percent of members going to overseas billets made ROT moves (the others made operational or accession moves). Rotational moves involve transoceanic shipment of household goods. All personnel stationed overseas do not make

moves that require transoceanic shipment of household goods. For example, a member may rotate from shore duty in Hawaii to sea duty in Hawaii and vice versa. Commander Keller's analysis further showed that eighty-five percent of members leaving from overseas tours made rotational moves. [Ref. 5: p. 4]

To determine the total number of ROT moves from overseas, the data in the Enlisted Master Record (EMR) was used to obtain the number of fiscal year 1990 PRDs for those personnel in overseas billets. Subtracted from this figure are the number of fiscal year 1990 expected separations (19% of total PRDs), estimated fiscal year 1990 "other losses" (5% of total PRDs), and fiscal year 1990 estimated annual extensions (5,500). Commander Keller had observed overseas extensions for the prior three years and felt this number had always been fairly consistent. These estimates were based upon Commander Keller's past experience. This adjusted PRD figure was then multiplied by the move rate from overseas (85% of overseas PRD rollers) to obtain the gross estimate of moves from overseas.

Commander Keller subtracted one percent of the gross number of moves from overseas as a policy correction factor to account for erroneous overseas PRDs. Additionally, he added to this figure the estimated number of "immediate avails" expected to move during the forecast horizon. "Immediate avails" are people that are moved without regard to PRD. These moves would typically involve humanitarian

reassignments. The resulting number equals the net ROT moves from overseas.

Similarly, the number of ROT moves made to overseas assignments was determined by taking overseas PRDs and subtracting estimated overseas extensions from this figure. This figure represented the number of "rollers" needed to fill overseas billets. A "roller" is the unofficial term used by BUPERS budget planners to define service members who are being assigned from one permanent duty station to another. To decide the gross number of ROT moves made to overseas assignments, the number of "rollers" were multiplied by the percentage of ROT moves made to overseas assignments (59% of total PRDs). From this sub-total, Commander Keller subtracted one percent of the gross number of moves to overseas assignments as a policy correction factor. The result is an estimate of the net number of rotational moves made to overseas assignments. The forecast for all ROT moves equals the total net moves from and to overseas. The rotational move formulas are presented below. [Ref. 5: p. 4]

NET ROT MOVES FROM OVERSEAS (FY-90)

PRDs Overseas		31,109
Less:	Separations	6,004
	Other Losses	1,555
	Extentions	5,500
	= Rollers From Overseas	18,050
Times:	Rate from overseas (.85)	
	= Gross Moves From Overseas	15,342
Less:	Policy correction (1%)	153
Plus:	Avails	1,235
	= Net ROT Moves From Overseas	16,424

NET ROT MOVES TO OVERSEAS (FY 90)

PRDs overseas		31,109
Less:	Extentions	5,500
= Rollers To Overseas		25,609
Times:	Rate To Overseas (.59)	
= Gross Moves To Overseas		15,109
Less:	Policy Correction (1%)	151
= Net Rot Moves To Overseas		**31,382**

TOTAL ROT=NET ROT MOVES FROM OVERSEAS + NET ROT MOVES TO OVERSEAS

c. *Operational Moves (OP)*

To estimate OP moves, the model starts with the total number of PRDs for the fiscal year. Next, the moves "to training," (1/2 of the total TRA moves) are subtracted from this figure as well as the total number of ROT moves, overseas separations and other overseas losses, and overseas extensions. The difference is the number of OP move "rollers." From this number, subtractions are made for a one percent policy correction (1% of OP move "rollers") for erroneous PRDs, the number of estimated separations for fiscal year 1990 (19%), other estimated losses for fiscal year 1990 (5%), and the number of estimated extensions for fiscal year 1990. These estimates were based on historical data on file at Pers-20. No-cost moves are also subtracted from this total. An estimate of 25% of total moves (OP, ROT, and TRA) is used. This 25% estimate was based on observations made over several years. Finally, added to this figure are the number of members who are expected to be immediately available for a PCS move. The result is the total OP moves. The calculations are presented below.

ENLISTED OPERATIONAL MOVES (FY-90)	
Total PRDs	150,341
Less: TO Training moves	13,870
ROT moves	31,382
Overseas Seps.	6,004
Other Overseas Losses	1,555
Overseas Extens.	5,500
= Operational Moves	92,030
Less: Policy Correction (1%)	920
Seps.	17,762
Other Losses	4,601
Extensions	1,800
No-cost moves	44,000
Plus: Avails	9,210
= Total Operational Moves	**32,156**

3. Model Assumptions and Adjustments

Commander Keller provided the following comments regarding the model's assumptions and errors: [Ref. 5: p. 5]

a. When inputing estimates to the model, a deliberate attempt was made at providing conservative estimates. This was done to ensure that if errors in forecasting PCS moves are made, that these errors are over-forecast errors rather than under-forecast errors. The motivation behind this was to be able to provide some degree of "detailer flexibility" allowing him/her to make a move that might not be totally aligned with PCS policy, but that makes good PCS move sense. In retrospect, Commander Keller feels

that the figure for combined total "losses" for Operational Moves appears too high (estimated separations plus other losses was 24% in FY 90). Commander Keller thinks a more accurate total loss rate would be closer to twenty-three percent.

b. The method used to determine TRA moves was not as accurate as it could have been for two reasons: 1) the Navy fails to fill all school quotas, and 2) the TRA move formula fails to account for co-located training (i.e., two or more training courses, which by themselves are each less than twenty weeks, but when combined total twenty weeks or greater). For example, co-located training would include submarine training schools where a member graduates from a basic course to a more advanced course given at the same geographic location. Co-located training in excess of twenty weeks constitutes a PCS training move. Commander Keller felt that these two differences would offset each other, thus still providing a reasonable approximation of the PCS move requirement.

c. In determining the ROT move rate for members departing from assignments outside the continental United States, the model should have considered only those members returning to the continental United States. In failing to do so, the model double counts rotational moves executed for those members who will be serving consecutive overseas tours.

d. Commander Keller deliberately underestimated extensions overseas and in CONUS. For FY 92, he estimates that extensions overseas are underestimated by approximately 1,000 and extensions in CONUS by 700. [Ref. 5: p. 5]

e. In determining the ROT moves from overseas, the gross number of moves was determined and then the policy correction factor was deducted. The policy correction factor should have been deducted from the number of moves from overseas prior to obtaining the gross moves figure.

f. A random sample of the Enlisted Master Records (EMR) revealed that the rate of erroneous overseas PRDs was approximately three percent and that the rate of erroneous CONUS PRDs was approximately five percent. To increase model accuracy, these percentages would need to be adjusted for in the model.

4. Analysis

The Pers-20 model, developed by Commander Keller, has been evaluated for its accuracy in forecasting total enlisted PCS cost moves. A comparison was made by the author between actual moves and the forecast for the fiscal years from 1989 through 1991. The percentage deviation between the actual values and the estimates was used as a measure of forecast accuracy using the following formula:

[forecast-actual/actual]

These values and the percentage forecast error are shown in Table 9.

TABLE 9.--TOTAL ENLISTED COST PCS MOVES FY 89-91 (PERS-20 MODEL FORECAST COMPARISON)

FY	Forecast	Actual	Error (Percent)
89	92,167	93,931	-1.88
90	91,278	95,778	-4.70
91	91,822	99,253	-7.49

Source: NPRDC; CDR Keller

In evaluating the model in terms of forecast accuracy, one can see that the margin of error is increasing in each of the three fiscal years for which the model was run. Commander Keller viewed this situation in two ways. First, he believes that there was not an execution monitoring system in place to ascertain how well assignments followed policy direction during this period. Secondly, Commander Keller claimed that if a correction was applied to the model based on the first year's performance, then the rate of error would have remained constant, at least for the first two years.

In comparing Table 3 (p. 36) and Table 9, the results show that the Pers-20 model developed by Commander Keller outperformed the NPRDC PCS ORT model for FY 1989 through FY 1990. However, measuring forecast accuracy in terms of execution can cause forecast accuracy problems. There are two primary reasons for this. First, to some extent there is, in

a given fiscal year, a causal relationship between the forecast error and the number of moves actually executed. This was explained in more detail in Chapter III. Second, in an environment in which the objective is to spend all the PCS funds allocated for a given fiscal year, it is hard to determine the actual requirement. One suggestion to remedy this situation might be to make only those moves in a given fiscal year that were budgeted for.

Commander Keller and the author made some adjustments to the Pers-20 model in an attempt to improve forecast accuracy. It is first necessary, however, to provide some background relevant to these adjustments.

a. Background on the Pers-20 Model Adjustments

In the first interview the author conducted with Mr. Ed Timco, Head of Automated Information Systems Support for Pers-7, Mr. Timco stated that any forecasting model based on PRDs probably is not an accurate forecasting method. As all the models reviewed during the research were based on first determining PRDs, this was alarming. Mr. Timco went on to explain that PRDs can and are changed by the detailers quite frequently. In his opinion, detailers are an end-motivated group of individuals whose primary concern is to get the member moved. This is probably as it should be; however, it does cause some problems with the validity of using PRDs as a planning tool.

Another problem was discovered during the research. Many members are moved in advance of their PRDs. This could result in an increase in PCS requirements since unprogrammed moves (which were anticipated in the next fiscal year) from a subsequent fiscal year could deplete current year funding. The problem is one of data source reliability with respect to PRDs. Additional research revealed that, as orders are written, the PRD is erased from the Enlisted Master Record (EMR). This is critical because the author was interested in obtaining a survey of an actual move distribution versus the respective PRDs.

Commander Al Rouse, Head, Pers-203, conducted a study in August 1991 in which he matched PRDs to their estimated date of departures (EDDs), which is set by the detailer. Commander Rouse obtained his data from the MFS system. The purpose of this study was to compare the planning assumptions (i.e., PRDs) with the actual distribution behavior (i.e., EDDs). Results from this analysis revealed that, in FY 90, thirty-eight percent of moves were early by an average of eleven months. Of these early moves, fifty-four percent, or approximately 25,000, were made using funding from outside the fiscal year in which the move was programmed. This is significant because, as mentioned earlier, moves made from the ensuing fiscal years are neither programmed nor budgeted for in the current year. Similarly, data from 1991 revealed that thirty-five percent of PCS moves were an average of 11 months

early and fifty-two percent of these were outside the fiscal year in which the move was programmed. [Ref. 6: p. 2]

Commander Rouse noted in the analysis that the majority of early detachments were either based on current sea/shore rotation policy, or were accomplished for career progression purposes. The magnitude of the numbers, however, would appear to back up the statement made by Mr. Timco regarding the suspect reliability of PRDs as the basis for PCS budget forecasting. Commander Rouse's analysis further estimated that the unprogrammed costs could be as high as $83 million for the FY 1991 moves which were made from outside the fiscal year in which the move was programmed. This calculation was based on the number of early moves by type and the average cost per move, also by type. [Ref. 6: p. 3]

b. Adjustments Made to the Pers-20 Model

An attempt was made by Commander Keller and the author to apply a correction factor to the Pers-20 model based on the results of the analysis conducted by Commander Rouse. Two techniques were employed to accomplish these adjustments, which the author shall label adjustments "inside" the model and adjustments "outside" the model.

(1) Adjustments "Inside" the Model

Commander Keller felt that if the percentages of early moves identified in Commander Rouse's analysis can be applied equally to both cost and no-cost moves, then the

formulas for the Operational and Rotational moves could be adjusted within the model based on the corresponding early move percentages. The model could then be rerun and the results compared with the original forecasts to determine if forecast accuracy is improved. Training moves were not adjusted since there are a finite number of quotas and, consequently, it is difficult to over-abscribe this move category. [Ref. 7: p. 2]

Rotational (ROT) moves required two adjustments, one for moves "from overseas" and another for moves "to overseas". First, for ROT moves "from overseas," the one percent policy correction factor in the original model was zeroed out. Next, the number of "immediate avails" was changed from a constant (1,235) to a percentage of ROT moves made early based on Commander Rouse's calculations. The number of ROT moves "to overseas" was similarly calculated.

For Operational moves the methodology was the same (i.e. basically zeroing out all policy correction factors and previous immediate avails figures and then adding back the percentage of Operational moves projected as being "early"). The number of Operational moves, which in effect are a residual from the number of Rotational moves, was still determined based on the originally scheduled PRDs for Rotational moves. The revised Keller model was then run; the results are presented in Table 10. Comparing Tables 9 and 10,

the percent forecast error is greater in FY 90, but lower in FY 91.

TABLE 10.--CORRECTION FACTOR APPLIED INSIDE THE MODEL

FY	Forecast	Actual	Error(Percent)
90	106,398	95,778	11.08
91	102,602	99,253	3.30

(2) Adjustments "Outside" the Model

It is the author's opinion that the model developed by Commander Keller is subject to some amount of stochastic error simply by design (i.e., it is a simple model and is not intended to precisely capture every determinant of move behavior). Additionally, there are numerous random factors affecting execution each period. Further refinement of the model, therefore, might not provide a more accurate forecast. The author decided to apply a simple correction factor to Commander Kellers model's results rather than adjust the various equations which make up the model.

Additionally, the author disagreed with Commander Keller on at least one important point: that training moves would also have to be adjusted to account for early moves. Despite Commander Keller's assumption that you cannot over-ascribe training moves due to a finite number of quotas, training moves do occur early. This might be due to schools having more seats available than students, or an assignment policy

that allows for PRDs to be adjusted to fulfill training requirements. The latter is more likely since thirty-five percent of all training moves in FY 91 were executed prior to the schedule PRD.

The author's results, which are displayed in Table 11, were determined by taking the original forecasts for FY 90 and FY 91, and applying a correction factor of 20.1% and 18.2% respectively, in order to account for the moves that occurred from subsequent fiscal years. The 20.1% was derived following the logic that 38% of FY 90 moves were early and of these, 53% were outside the fiscal year. The subsequent result is that 20.1% were early and outside FY 90. The FY 91 correction percentage was derived similarly. After applying this correction factor, all other correction factors and Commander Keller's previous adjustments for "immediate avails" were eliminated. Comparing Table 11 to Tables 9 and 10, the forecast error is the smallest in Table 11.

TABLE 11.--CORRECTION FACTOR APPLIED OUTSIDE THE MODEL

FY	Forecast	Actual	Error (Percent)
90	98,876	95,778	3.23
91	97,666	99,253	-1.60

(3) Comments on the Pers-20 Model

The Pers-20 model, developed by Commander Keller, provides a logical conceptual foundation from which further refinements are necessary to enhance the model's usefulness as a forecasting tool. Commander Keller's model shows some improvement over prior forecasting procedures, which relied on extrapolation from historical data. This model is the first attempt to link move behavior to independent variables and to identify the causative determinants of PCS move requirements.

The author feels the Pers-20 model is superior to the NPRDC PCS ORT model for three reasons: 1) the model did better than the NPRDC model in terms of forecast accuracy in fiscal years 1989 and 1991; 2) there is no additional cost for collecting the data or for maintaining the model; 3) the model equations can be easily altered when either new factors which affect PCS moves are identified or when move policies are changed. [Ref. 1: p. 6]

There is, however, a need for an improved model. With today's tight fiscal budgets, the Navy can ill-afford the luxury of miscalculating PCS move budget requirements by the range of forecasting errors that have been observed in both of the models reviewed. However, some of the factors that contribute to these errors were identified. This could lead to improved forecasting accuracy if considered in concert with a review of existing PCS policies.

One suggestion for the Keller model is that extensions, both overseas and in CONUS, be made constants in the model. This could be documented in the model as an independent variable with separate retention statistics applied for first and second term enlistees as well as for careerists.

The final question remains. Does the Pers-20 model developed by Commander Keller improve the status quo? Based on the above analysis, the author feels that it unquestionably did.

B. QUANTIFYING THE IMPACT OF THE PERMANENT CHANGE OF STATION (PCS) BUDGET ON NAVY ENLISTED PERSONNEL UNIT READINESS

Readiness of the Fleet has always been a paramount concern of Navy commanders whether serving ashore or at sea. It follows then that a principle concern of budget officers when faced with a PCS account reduction is to try to assess the impact of this reduction on readiness. This is not easy to do. The criteria that comprise readiness are rather nebulous and hard to quantify. Nevertheless, there are those who recognize the importance of being able to defend the PCS budget in terms of readiness impacts. One of those who recognized this importance is Captain Dick Hayes. His efforts to develop a model which could show the effects of budgets cuts on readiness are discussed below.

1. Background

While serving as head of BUPERS Distribution Management and Control (Pers-46), Captain Hayes saw the need for a model that could answer the following question: "If we cut the PCS budget by $20 million, what are the effects on readiness?" It was his belief that cuts which occur to the PCS budget during the budget review process were detrimental to fleet readiness. Captain Hayes was willing to sponsor a model that would give you the "what-if" effects of a budget cut. The model, which was developed by NPRDC in 1991 under his sponsorship, is titled "Quantifying the Impact of the Permanent Change of Station (PCS) Budget on Navy Enlisted Personnel Unit Readiness." [Ref. 8: p. 1] The approach taken by the NPRDC model developers is described below.

2. Approach

In searching for a way to measure the impact of a PCS budget cut, the NPRDC model developers turned to the existing framework by which the services estimate unit readiness. All operational service units are required to submit Status of Readiness and Training reports (SORTS) on an as required basis to keep the Joint Chiefs of Staff (JCS) advised of each unit's state of readiness. Part of the SORTS report contains information on personnel readiness. The NPRDC model was developed using this personnel readiness rating. However, some refinement of this personnel readiness measure was

necessary. This was due to the fact that, as they currently exist, personnel readiness measures cannot distinguish among small differences in manning levels.

The Navy measures fleet personnel readiness using a scale known as the C-rating. For example, a C-1 rating signifies that a unit is fully combat ready. A C-2 rating means substantially combat ready, and a C-3 rating means marginally combat ready, while a C-4 rating means not combat ready. Within these broad categories, a ship's manning (personnel/billets) can vary by nearly ten percent without altering the ship's C-rating. A more accurate readiness measure was needed to account for the effects of PCS moves. [Ref. 8: p. 1]

In addition, measuring fleet personnel readiness includes complex resource allocation decisions. Fleet personnel readiness measures involve the use of a unit's manning level and mission area (e.g., mobility, antisubmarine warfare, etc.). A unit is given a C-rating based on its lowest mission area rating. There are up to nineteen mission areas possible and each mission area contains personnel in multiple occupations and skill levels. Therefore, a given occupation or skill level can contribute to the readiness of multiple mission areas. Determining the best way to allocate resources under these conditions remains a difficult problem. [Ref. 8: p. 1]

Mission area personnel readiness ratings (M-ratings) range in value from M-1 to M-4. An M-1 rating for a mission area such as anti-air warfare (AAW) would signify that there are enough personnel with the proper qualifications to effectively perform the AAW mission. An M-4 rating denotes severe deficiencies, and the inability to perform in that mission area.

The M-ratings are based on manning within pay grades E-1 through E-9. Table 12 shows the manning levels that are used to determine the M-rating for a mission area. The table shows, for example, that the M-rating for a unit is M-1 if the manning for pay grades E-1 to E-9 (collectively) is at least ninety percent and the manning for pay grades E-5 to E-9 is at least eighty-five percent. The specified manning levels for both the E-1 to E-9 group and the E-5 to E-9 group need to be satisfied. If E-1 to E-9 manning is ninety percent, while the E-5 to E-9 manning falls to eighty percent, for instance, then the mission area is classified as M-2. [Ref. 8: p. 2]

TABLE 12.--CRITERIA FOR DETERMINING M-RATINGS

Mision Area Readiness Rating (M-rating)	Manning for Paygrades E-5 through E-9	Manning for Paygrades E-1 through E-9
M-1	85% and above	90% and above
M-2	75%-84%	80%-89%
M-3	65%-74%	70%-79%
M-4	less than 65%	less than 70%

Source: NPRDC

As seen in Table 12, the rating scales are unresponsive to relatively small changes in manning levels. For example, a unit with seventy-eight percent manning in pay grades E-5 through E-9 and eighty percent manning in pay grades E-1 through E-9 would be classified as M-2. If E-5 through E-9 manning were increased six percent and E-1 through E-9 were increased nine percent, the unit would still be classified as M-2. To overcome this problem, NPRDC devised the continuous readiness measure presented below. [Ref. 8: p. 3]

Let x be the pay grade E-5 to E-9 manning percentage and y be the E-1 to E-9 manning percentage, then the continuous readiness measure level r is given by:

$$r = 10 - \frac{\min[(x + 5), y]}{10}$$

The current readiness measure (M) can be defined in terms of r as follows:

$$M = \begin{cases} \mathbf{1} & \text{if } r \le 1 \\ \mathbf{2} & \text{if } 1 < r \le 2 \\ \mathbf{3} & \text{if } 2 < r \le 3 \\ \mathbf{4} & \text{if } r > 3 \end{cases}$$

Again, a unit's readiness value is equal to the lowest level among its mission areas. [Ref. 8: p. 3]

A comparison of the current Readiness Measures (M-ratings) and the NPRDC continuous measures is presented in Table 13. The results show a significant improvement in the ability to differentiate between relatively small changes in personnel readiness.

TABLE 13.--COMPARISON OF READINESS MEASURES (M-RATINGS)

E-5 - E-9 Manning	E-1 - E-9 Manning	Continuous Measure	Current Measure
85	90	1.0	4
84	89	1.1	2
83	88	1.2	2
82	87	1.3	2
8[illegible]	86	1.4	2
80	65	1.5	2
79	84	1.4	2
78	73	1.7	2
79	80	2.0	2
74	79	2.[illegible]	3
73	76	2.[illegible]	3
72	8[illegible]	2.[illegible]	3
71	76	2.4	3
70	79	2.5	3
66	80	2.6	3
65	73	2.[illegible]	3
67	72	2.8	3
66	8[illegible]	2.9	3
65	76	3.0	4
60	69	3.1	4
63	65	3.[illegible]	4
62	67	3.[illegible]	4
61	66	3.4	4
60	65	3.5	4
57	62	3.8	4
56	61	3.9	4
55	60	4.0	4

3. Relating Readiness to PCS Moves

NPRDC uses two data files maintained by the Enlisted Personnel Management Center (EPMAC) as a source of input to a PC-based program called READY. This computer program was designed to relate PCS moves to personnel unit readiness. The two data files, labeled U1 and U2, contain information on organizational personnel shortages and personnel requirements, and the corresponding mission areas. Based on this input, the READY model then allocates moves by Unit Identification Code (UIC). [Ref. 8: p. 5]

The READY program is able to provide two capabilities that did not exist before in a single model. These new capabilities are: 1) the ability of the model to calculate the manpower demands for separate mission areas based on a continuous readiness measure; and 2) the ability of the model to calculate moves for all readiness measures simultaneously. The model also computes the number of moves required to achieve a range of readiness levels. READY focuses on moves for any desired time horizon within the next twelve months. READY accumulates the moves, which improve readiness from r to $r - \delta$, where $\delta = .05$ and $r = 10, 10 - \delta, 10 - 2\delta, \ldots, 1$. In addition, information by unit and mission area is kept in an internal table for producing a cumulative readiness curve. A detailed description of the READY program, to include how READY accumulates the moves to improve readiness, is provided in Appendix A. [Ref. 8: p. 6]

4. READY Model Results

In a hypothetical example, the READY model was used to estimate the impact on readiness resulting from a reduction in the PCS budget. Table 14 is an example of a PCS move plan for a five-month period. For each type of move, Table 14 shows average cost per move, currently planned moves and their cost, as well as reduced budget moves and their cost. [Ref. 8: p. 7]

TABLE 14.--HYPOTHETICAL PCS MOVE PLAN UNDER CURRENT AND REDUCED BUDGETS

Type of Move	Cost per Move	Current Budget Moves/ Cost ($M)		Reduced Budget Moves/Cost ($M)	
OP	$2400	10,500	$25.2	7,875	$18.9
ROT	$4400	1,800	$7.9	1,620	$7.1
TRA	$1200	5,000	$6.0	5,000	$6.0
Total		17,300	$39.1	14,495	$32.0

In this example, the current budget is $39.1 million, while the reduced budget is $32.0 million. The current move plan is for 10,500 operational, 1,800 rotational, and 5,000 training moves. The reduced budget plan calls for 7,875 operational, 1,600 rotational, and 5,000 training moves. [Ref. 8: p. 7]

In calculating the effect that a reduction in moves has on readiness, NPRDC estimated the percentages of each type of move that affect readiness. These estimates used historical

billet and personnel data obtained from EPMAC. The results showed that thirty-eight percent of operational, twenty-five percent of rotational, and zero percent of training moves affect readiness. The reason that training moves were estimated to have no affect on the readiness measure is that most shore based units are not included in readiness reporting, hence no readiness calculation exists for them. The model sponsors recognized this as a shortcoming of the READY model.

To get the number of moves affecting readiness under the current and reduced budget move plans, the estimated percentages of operational, rotation, and training moves which affect readiness are multiplied by the number of moves in Table 14. Table 15 provides the calculated number of moves affecting readiness under the current and reduced budget move plans. The results show that the reduction in moves translates to a drop in readiness from 1.85 to 2.30 under the reduced budget. [Ref. 8: p. 8]

TABLE 15.--UNIT READINESS MOVES AND READINESS RATING

Type of Move	Readiness Moves Under the Current Budget	Readiness Moves Under the Reduced Budget
OP	3990	2993
ROT	450	405
TRA	0	0
Total	4440	3398
Readiness	1.85	2.30

5. Comments on the Performance of the READY Model

The model described above was able to estimate the impact on mission and personnel unit readiness given a reduction in the number of PCS moves. It was also able to estimate the total number of moves required to bring all units in the simulation up to a readiness level of 1.0. As noted earlier, the model cannot gauge the impact on readiness for shore commands because most shore commands are not included in the readiness calculations to begin with. The NPRDC model developers believe that this shortcoming could be easily overcome by expanding the definition of readiness to cover all units. This expanded definition would be analogous to the M-rating criteria already used by operational commands.

These attributes led the author to conclude that this model has significant potential as a tool in supporting PCS budget proposals. Captain Caroline George, Head, Allocation Division (Pers-45), stated that the model seems best suited

for considering readiness just for manning purposes. However, Captain George also maintained that the model could be used in justifying the PCS budget. Attempts to obtain additional critiques of the model were hampered due to the fact that most of those contacted were not aware of the model's existence or the current status of the model.

6. Status of the READY Model

Further development of the READY model by NPRDC has been terminated pending future funding for expansion of the model. The official report on the model was released to BUPERS in June 1991. AT the time of the report's release, the model's sponsor had rotated, and other key leaders who had championed the project had either rotated or retired. The Head, Distribution Support (Pers-47), had been the original sponsor of the project. However, Pers-45 has since been designated as the decision point for research and development projects for Pers-4. The model was not on the Pers-4 research and development projects list for fiscal year 1992.

V. CONCLUSIONS AND RECOMMENDATIONS

A. OVERVIEW

This chapter provides conclusions and recommendations based on the research presented in the previous four chapters. Both conclusions and recommendations will be presented in two parts: 1) those pertaining to the PCS forecasting models, and 2) those dealing with the PCS planning process.

B. CONCLUSIONS

1. PCS Forecasting Models

The Bureau of Naval Personnel (BUPERS) currently lacks a PCS move forecasting model that provides accurate and reliable forecasts to support annual budget requests. In addition, the existing forecasting models are unrelated to actual execution behavior. Finally, none of the forecasting models can estimate the impact of various policy changes on PCS move requirements. Consequently, there is a need for a PC-based interactive forecasting model that can provide an on-line query capacity to address the "what if" types of questions pertaining to changes in PCS policies or other influencing external factors.

The NPRDC PCS ORT Moves Forecasting Model is insufficient to meet the needs of budget planners. Because it is a time-series forecasting model, it is insensitive to policy changes

until a year or more after the change has been implemented. The review of forecast accuracy presented in Chapter III revealed that an unacceptably high margin of error existed in fiscal years 1989 and 1991. The errors for these years are -8.09% and -8.43% respectively. In addition, the model is unrelated to actual move execution behavior. During the execution phase of PCS management, there needs to be some method of linking the most recent move execution to move requirements for the remainder of the fiscal year. Pers-463, the execution manager, sees this as the most deficient aspect of the model.

The Pers-20 model, developed by Commander Keller, was the first attempt to link move behavior to independent variables, and to identify the causative determinants of PCS move requirements. Operated on a Macintosh spreadsheet, the model outperformed the official NPRDC model in terms of forecast accuracy, and had the added benefit of being able to easily alter the equations that make up the model when policy variables are changed. More importantly, the model was developed at little cost to the Navy. The Keller model, however, is also subject to some of the shortcomings discussed in relation to the NPRDC PCS ORT model. The margin of error for the model is increasing in each of the three years for which data is available and the model is also unrelated to execution behavior.

The READY program, developed by NPRDC as a means of quantifying the impact of "PCS" budget reductions on personnel unit readiness, was analyzed and the results are encouraging. This model may turn out to be very useful as a method of assisting in the formulation of impact statements during budget review. The author feels that the recent initiatives to develop a new PCS forecasting model should also include the READY program as a sort of "backend" calculation. This program was designed to run on a personal computer. After obtaining forecasts from the PCS model, the output could be entered into the READY program. This would allow alternative move programs to be analyzed with respect to readiness impacts. This will be addressed in further detail in the recommendations section.

The need exists, therefore, for a new PCS forecasting model. There does not exist the latitude in the PCS program today for the range of errors observed in both the PCS forecasting models reviewed. At the time of this writing, Commander Rouse, Head, Pers-203, was chairing a Quality Management Board (QMB) that is designing a new PCS forecasting model based on enlisted end strength.

2. The PCS Planning and Budgeting Process

The management and budgeting of PCS funds is hostage to several process constraints. The author explored these process constraints for two reasons: 1) the Navy has embraced

Total Quality Leadership (TQL) and process improvement constitutes the very bedrock of TQL, and 2) financial managers expressed frustration with some of the artificial barriers that existed between the organizations involved with PCS management and budgeting. These barriers interfered with the flow of information and communication. Each of the process constraints will be addressed separately below.

The current two-step costing process introduced in Chapter II is problematic given poor data source reliability. In addition, in the author's opinion, the process is burdensome and inefficient. First of all, PCSVAD, Cleveland, has historically only received approximately fifty percent of the Travel Information Forms (TIF) upon which the step II cost is based. This means that the remaining, uncosted PCS moves must be obligated based on the original step I reservation cost. It is both time consuming and costly to go through this process of matching reservations with obligations when they only receive half of the input data to begin with.

Secondly, the Permanent Change of Station Variance Analysis Department (PCSVAD) has existed since the mid-seventies. As its name would imply, it is tasked with analyzing variances between step I reservations and step II obligations. It is the author's opinion that they should be able to gauge the approximate difference between the reservation and obligation amounts. This would support the

elimination of the step II cost estimation, as they should be able to approximate the impact of step I costing.

Thirdly, the author investigated whether the information contained on the TIF could be automated with the information being entered on the Detaching Endorsement Form 3067, which is automatically sent out coincident with a member's detachment from the command. Presumably, this would bring the compliance rate up to 100%. Pers-7 budget planners rejected this idea, stating that there was too much information to transfer onto a Form 3067. Further investigation revealed Pers-103, the Requirements Section of the Source Data System Division, had already drawn up specifications for such a form in May of 1990. However, there are no development plans for this form at the present time due to manpower and funding constraints.

Fourth, PCSVAD employs approximately 30 civilian personnel for PCS processing activities, of which approximately 15 are data entry clerks charged with entering the data from the TIF into the PRODS system. The author feels that whether you automate the TIF form or do away with the second step in the costing process, you will realize substantial cost savings that could be used to move sailors.

Finally, the author sensed from the interviews conducted with the Pers-4 and Pers-7 budget officers, that a major impediment to implementing a one-step costing process was the inability of Pers-7, who as the central manager for the MPN appropriation is responsible for expending the PCS account, to

work in concert with Pers-4, who manages personnel distribution. If the PCS budget account is overspent, Pers-7 is responsible, and therefore, may be unwilling to relinquish to Pers-4 this extra control over the detailing process. If each organization were assigned a supporting role to assist the other in performance of the other's primary functions with respect to PCS management, then this could be avoided. Again, this is also in line with the TQL previously mentioned. Specifically, Point Nine of Deming's 14 points, calls for the breaking down of barriers between departments, and working as a team to foresee problems in production and procedures in use that may be encountered with the product or service. [Ref. 9: p. 1]

The data redundancy identified in Chapter II between the MFS and PRODS systems is a major source of inefficiency in the management of PCS funds. By maintaining obligation and reservation data on both BUPER's MFS and PCSVAD's PRODS, data is duplicated. As with any unnecessary redundancy, the possibility of inconsistency between the two data bases is high. When data, expected to be consistent, varies, time and energy must be devoted to unnecessary reconciliation. Valuable time reserved for constructive duties is often spent determining which data base is accurate. [Ref. 3: p. 22]

Recent interviews with Pers-7 and PCSVAD indicate that the PRODS and MFS databases will be merged some time within the next 12 to 15 months. In a phone conversation with Mr. John

Lorenz, Head, PCSVAD, of 5 November, 1991, he considered this time line for the merger of the two data bases optimistic. Mr. Lorenz also stated that he has drafted working papers outlining the functional requirements for this merger. A primary time consideration for this merger is that PCSVAD is considering using D-BASE II rather than the presently used sequential files. The merger presents an opportunity to consider implementing a one-step automated costing process coincident with the establishment of a single shareable data base for PCS data.

The Enlisted Automated Order Writing System (EAIS) does not perform up to the expectations of both the users (detailers) and financial managers. Several shortcomings with the EAIS were discussed in Chapter II, chief among these were the problems with the Customer Identification Code (CIC) construction and the requirement to input the step I costs manually. As a consequence of these system deficiencies, approximately fifty percent of the enlisted orders are written in the manual order writing system, RIS.

EAIS, as designed, also cannot provide updated detailer checkbook balances, which is desirable from a management standpoint. There also exists no direct link between EAIS/OAIS and PCSVAD. A direct link will eliminate the current flow of orders information from EAIS to NES, to MFS, and finally to PCSVAD. This direct link depends upon the maintenance of accurate cost data within EAIS. A suggested

target information flow is presented in the recommendations section of this Chapter.

C. RECOMMENDATIONS

1. PCS Forecasting Models

The following are recommendations for PCS forecasting models:

- **Reevaluate the continuance of the NPRDC PCS ORT Moves forecasting model.** The PCS Quality Management Board should examine this issue. This model has not been able to garner much support from the intended users in BUPERS during its three-year existence. As a time-series forecasting model, it is insensitive to policy variation. In addition, it is unrelated to actual execution behavior. Finally, the model requires an annual contract fee. With the Navy facing narrowing fiscal constraints, these funds might be better used elsewhere.

- **Develop a new PC-based PCS forecasting model.** This model needs to be capable of determining PCS move requirements for budget formulation as well as relating to monthly or weekly execution management. This model should be interactive between input sources (i.e., Pers-11 training statistics, retention statistics, and the Enlisted Master Files) and decision makers (i.e., Pers-4, Pers-7, & Pers-2). Finally, this model should be capable of estimating the impact of various policy changes or external factors which affect PCS move requirements (i.e., changes in sea/shore rotation policies, tour extensions (voluntary as well as those that result from policy changes), force structure changes and end strength reductions, retention effects, and readiness impacts of PCS account reductions).

- **Incorporate the readiness factor into the new PCS forecasting model.** Although still in the prototype stage, the READY program, developed by NPRDC, demonstrated the capability to estimate the impact on readiness resulting from a decrease in PCS funding. The program was designed to operate on a personal computer. A readiness moves curve is created, which has PCS cost moves on the y-axis and the continuous personnel readiness measure on the x-axis. Along this curve, alternative move programs can be analyzed with respect to readiness impacts. It is the author's opinion that the READY program or a similar

program could be used as a "backend" calculation in any new PCS forecasting model. This would enable financial managers to create impact statements during PCS budget review hearings.

- **Study the effects of the size of the Individuals Account (IA) on PCS moves.** The Individuals Account is a personnel overhead account. It consists of all those personnel who are either in training, or on medical or legal hold, and transient personnel who are in-between permanent duty stations. While this account varies, it averages approximately 11.5% of total enlisted end strength. The author believes that a study of the relationship between the IA size and PCS move requirements could be conducted using a regression analysis approach. During such a study, it would be useful to break down the population by its length of service (LOS) distribution. This might provide some insight into the indicators of move behavior among those in the IA, who together represent a significant portion of the total enlisted population.

2. The PCS Planning and Budgeting Process

The following are recommendations for the PCS planning and budgeting process:

- **Conduct a high-level review of PCS policies.** Interviews with detailers during this research revealed that certain PCS policies are restricting detailer flexibility. For example, policies implemented to improve retention are still in place which cause early detachments even though retention is at an all-time high. [Ref. 10] Another comment received was that, while many of these policies made sense individually, when considered in the aggregate, they can become unmanageable. One Commander likened it to entitlement spending in the Federal budget. The author investigated if there was any way of capturing the effects of certain policies on PCS move requirements. The result is that this would be extremely difficult for two reasons: 1) a lot of the policies do not remain in effect long enough to discover if any trend exists, and 2) new policies are constantly being implemented. The PCS QMB has conducted a comprehensive detailer survey of policy impacts on distribution behavior. As of this writing, results are not available, but are expected soon. In addition, Commander Rouse plans, as a follow-on effort, to conduct a top-down review and cross-reference of existing policies. [Ref. 10]

- **Eliminate two-step costing.** The current two-step costing process is considered inefficient given poor data source reliability (TIF card submission compliance is approximately fifty percent). In addition, an improved automated one-step process would eliminate the burdensome process of matching reservation and obligation amounts, as well as providing an updated detailer checkbook balance as each set of orders is written. A one-step costing process with a direct link to PCSVAD is illustrated in Figure 6. Comparing this information flow in Figure 6 with that in Figure 4, one can see that this provides a more logical flow of information. Also, the author feels that with the emphasis placed on Quality Management by the Navy today, that the costing process should be done once, and done correctly. The Permanent Change of Station Variance Analysis Department (PCS VAD) has been in existance since the mid-seventies. It is the author's opinion that enough data exists to estimate the impact of one-step costing. In discussing this with Commander Rouse, the Chairman of the PCS QMB, he echoed this sentiment saying that they have more than enough of a sample size with which to conduct a statistical analysis. Implementation of this recommendation would allow PCSVAD to concentrate their energies on improving the one-step costing process rather than spending their time reconciling obligation and reservation amounts. Finally, implementation of this recommendation would eliminate the need for 15 civilian data entry clerks in PCS VAD. This is discussed in more detail in the next recommendation.

- **Automate the Travel Information Form (TIF).** While the author feels that the recommendation previously presented would eventually eliminate the need for the current TIF processing activities, he recognizes that there is reluctance on behalf of Pers-7 to undertake this solution. An alternative solution would be to automate the TIF. Automation of this form and introducing it as a requirement for local Personnel Support Detachments (PSDs) to submit in concert with a member's detaching endorsement (Form 3067), would increase compliance presumably to 100%. As mentioned previously, specifications for such a form have been drawn up in Pers-103 (Source Data Systems). However, no plans for development exist at this time. The primary factor to consider here is the cost savings that such action could achieve by automating this form. This action would eliminate the need for the 15 civilian data entry clerks at PCSVAD, Cleveland, charged with manually entering the TIF data into the PRODS system. These savings could be re-channeled into moving Navy personnel.

- **Reduce Data Redundancy.** The MFS and PRODS database systems basically perform the same function (i.e., matching PCS reservations and obligations). Valuable time is lost determining which report data is accurate, however, as format differences and timing factors create inconsistencies. Pers-7 does plan to merge these data bases in the future. Another major source of data redundancy exists because the automated enlisted order writer (EAIS) is still not fully operational. As a consequence, approximately fifty percent of enlisted orders are written in the manual order writing system (RIS). Contracting assistance should be obtained to bring this system up to full operational capability.

- **Automate Step One Cost Tables.** The detailer is constrained by having to manually enter the estimated PCS costs from the large, rather laborious step one tables. A separate automated cost module should be designed and implemented into EAIS. Past efforts to accomplish this task were part of another larger project. The project was terminated, and the step one automation effort, only a sub-routine of this failed project, was terminated as well. Any new attempts should be accomplished as an independent project.

Target Information Flow Architecture

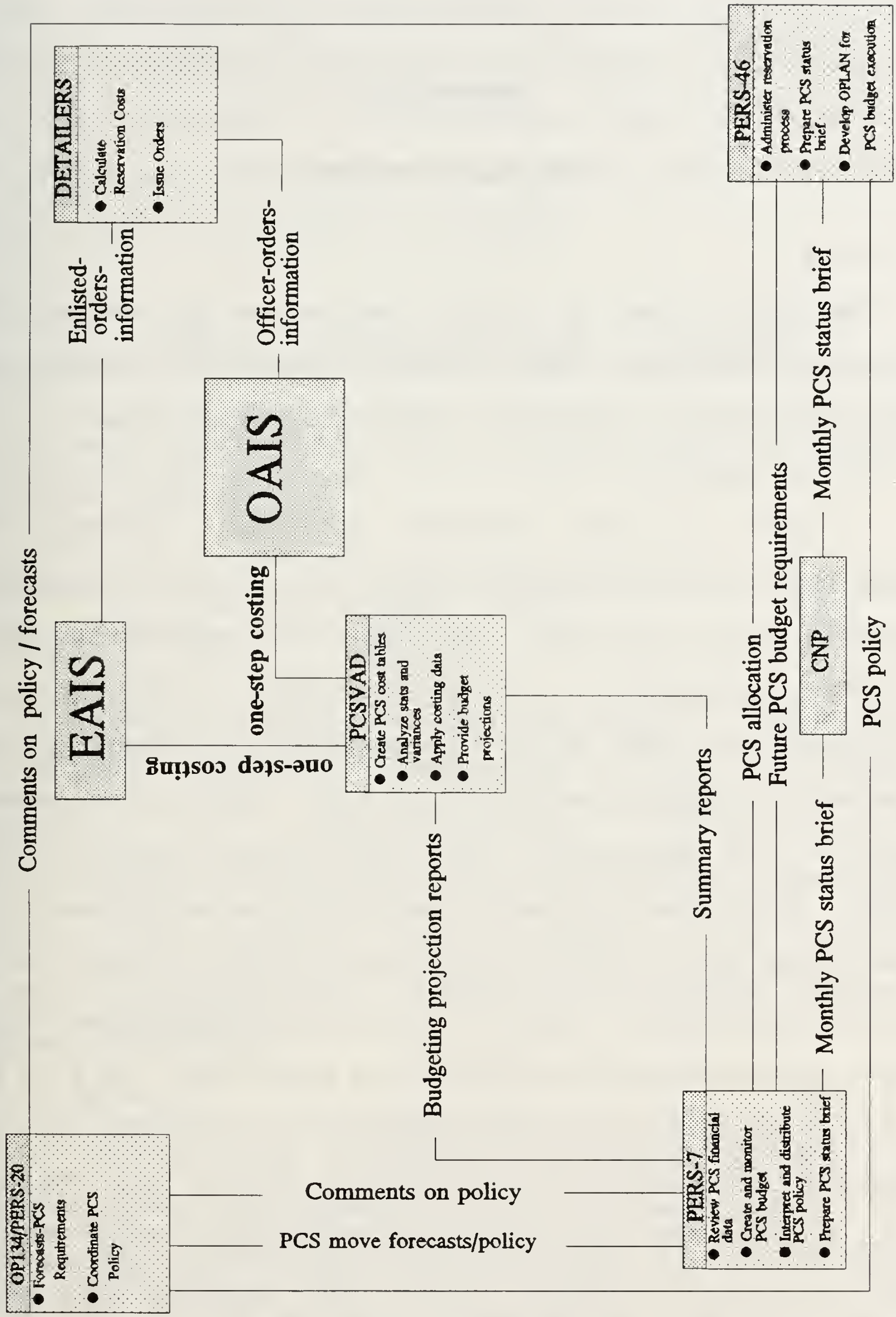

Figure 6

APPENDIX A

THE READY PROGRAM

A. DATA

Two data files, U1 and U2, maintained by the Enlisted Personnel Management Center (EPMAC) contain the manning and other information needed for readiness calculations.

1. U1 File

The U1 file contains personnel shortages in requirements and requirements (MOB+1) by activity, occupation, paygrade group, and time. Shortages are requirements minus on-board personnel. Activities are coded by unit identification code (UIC). Occupations are coded by rate code/Navy Enlisted Calssification (RCN). This is the members' rating or when appropriate their Navy Enlisted Classification (NEC). NEC is Navy enlisted classification and stands for a specialized skill. MOB+1 is requirements within 1 month of an actual mobilization. The U1 file contains indicators to show which mission areas are affected by a given RCN. The file has a record for each UIC and RCN combination. Only UICs that are included in readiness calculations are in this file. We will refer to this set of UICs as readiness UICs. There are 906 UICs and 15,097 records in the U1 file used for this work. These counts will vary somewhat over time.

The "shortages in requirements" in the U1 file are actually shortages in a predefined percentage of requirements. Let s equal shortages in requirements, q equal requirements and b equal on-board personnel. The U1 file doesn't contain b, so it must be calculated as follows:

$$s = 0.85q - b \quad \text{if paygrade group E-5 through E-9}$$
$$s = 0.90q - b \quad \text{if paygrade group E-1 through E-9}$$

The manning percentage (m) for paygrade group E-5 through E-9 can be calculated by:

$$m = \frac{b}{q} \times 100 = \frac{0.85q - s}{q} \times 100$$

The manning percentage for paygrade group E-1 through E-9 is similarly calculated. The values 0.85 and 0.90 above correspond to the M-1 readiness rating. The U1 file also contains values of s corresponding to M-2 and M-3 readiness ratings. These values of s are contained in the U1 file instead of the values of b to speed up interactive programs that use the U1 file.

2. U2 File

The U2 file contains personnel shortages in requirements and requirements by UIC and mission area. The shortages in requirements contained in this file are defined in the same way as in the U1 file above. The file has a

record for each UIC and mission area. There are 19 mission areas. Only readiness UICs are included. The U2 file contained 4,616 records in June of 1991. This count will also vary over time.

B. THE READY PROGRAM

READY, a FORTRAN program, was developed to calculate the demands of manpower for mission areas based on the continuous readiness measure. The program calculates moves for all readiness activities in a single run and READY calculates total moves by readiness level over a broad range of readiness levels, for all readiness UICs.

Program READY has input file U1 and U2. Also input to READY is the time parameter, t, ($t = 0, \ldots, 12$).

READY can be summarized in the following steps (see also the flow chart in Figure 7):

1. Determine all UICs with readiness level less than C-1 by finding the worst readiness level among the mission areas for that UIC. Put these UICs in a table for sequential processing.

2. If the table is empty, go to step 5; otherwise, for the current UIC find the mission area with the worst readiness level.

3. Check if the UIC satisfies the readiness requirement. If true, the current UIC is finished. Go back to step 2 and process the next UIC on the list. If false, continue.

4. Find the worst manned RCN that affects the mission area. Add one person to this RCN by paygrade group. The paygrade group that has more impact on readiness is used. If there is a tie, the upper group gets the person. Update the changes

caused by this additional person. Write out the RCN, mission area, and paygrade group for this move. Go back to step 2.

5. All UICs satisfy the readiness requirement; hence, create the cumulative readiness curve. Stop.

READY writes to an output file the table of UICs from step 1, together with its original readiness, the worst mission area and its manpower deficiencies for the two paygrade groups. The table is then sorted by UIC and mission area readiness. READY then accumulates the moves which improve the readiness from r to r-δ where δ is the step size of the curve (currently δ = 0.05) and r = 10, 10-δ, 10-2δ, ..., 1. Information from each move is accumulated and kept in an internal table for producing the cumulative readiness curve. Then, READY will write this information to the output file. Finally, when all moves are decided, READY writes the cumulative readiness data to a second output file.

A flow chart of program READY is presented in Figure 7. The program takes 2-3 minutes of CPU time and 2 megabytes of core storage to run on the IBM 4341 at the Navy Personnel Research and Development Center.

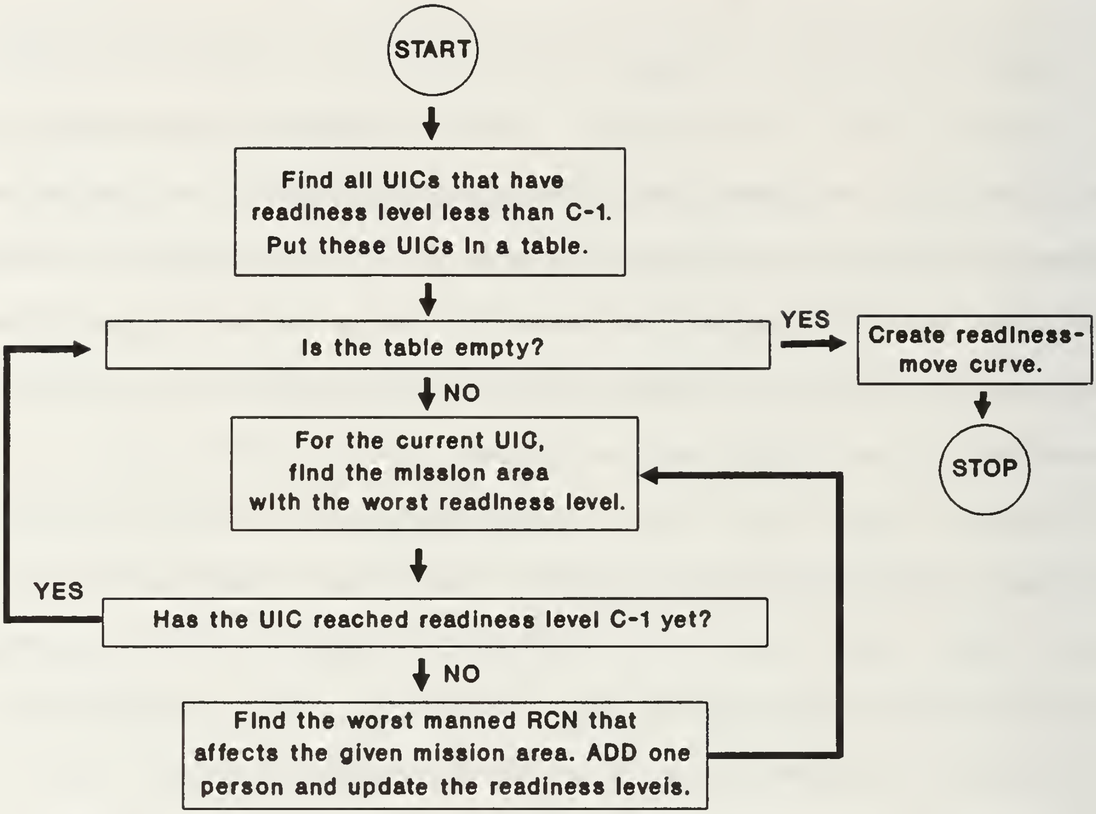

Figure 7--Flow Chart of the Ready Program

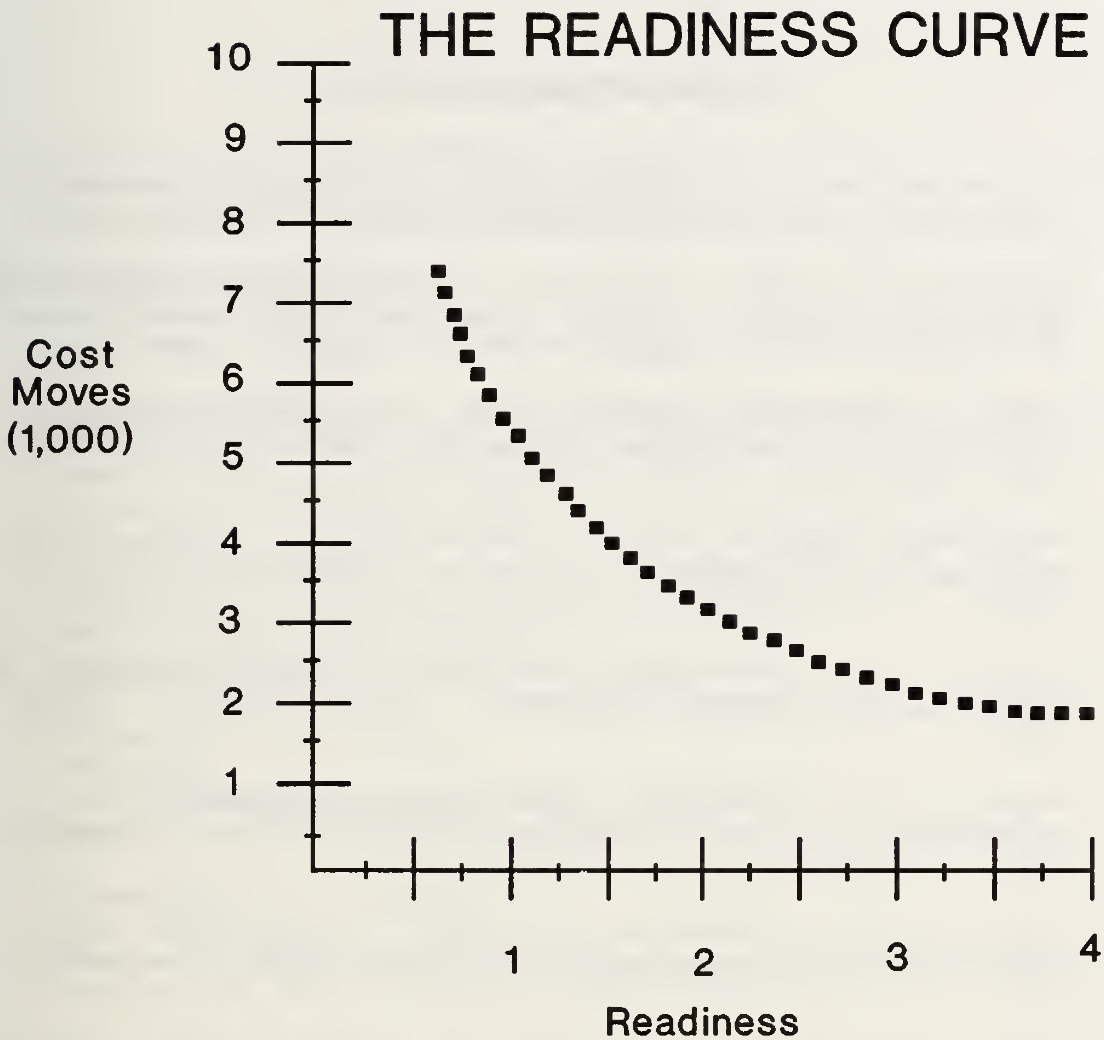
THE READINESS CURVE
10
9
8
7
6
5
4
3
2
1
Cost
Moves
(1,000)
1
2
3
4
Readiness

Figure 8

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